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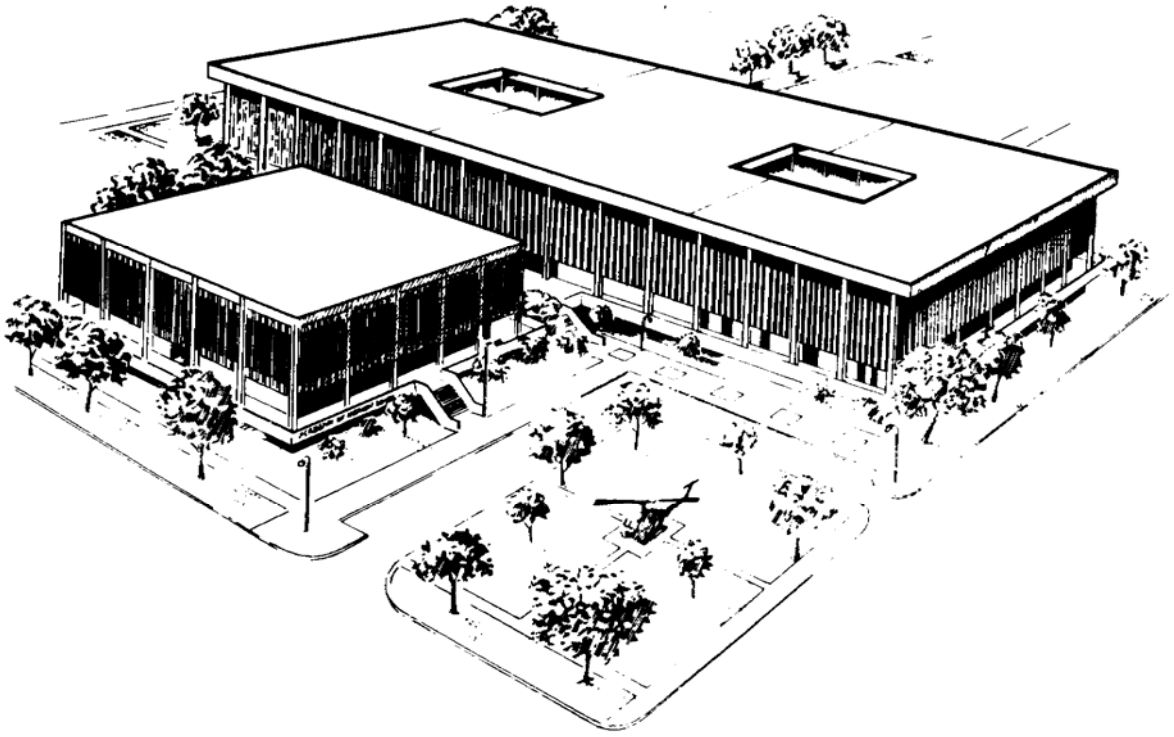
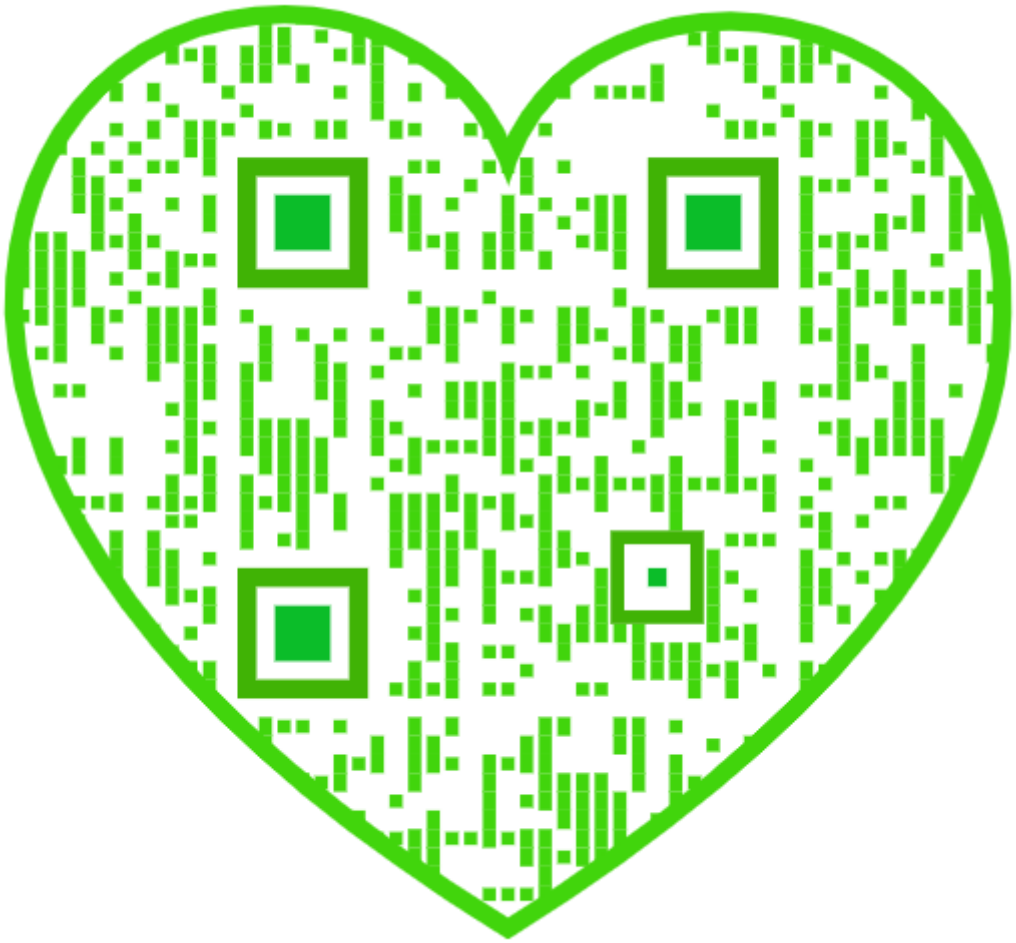
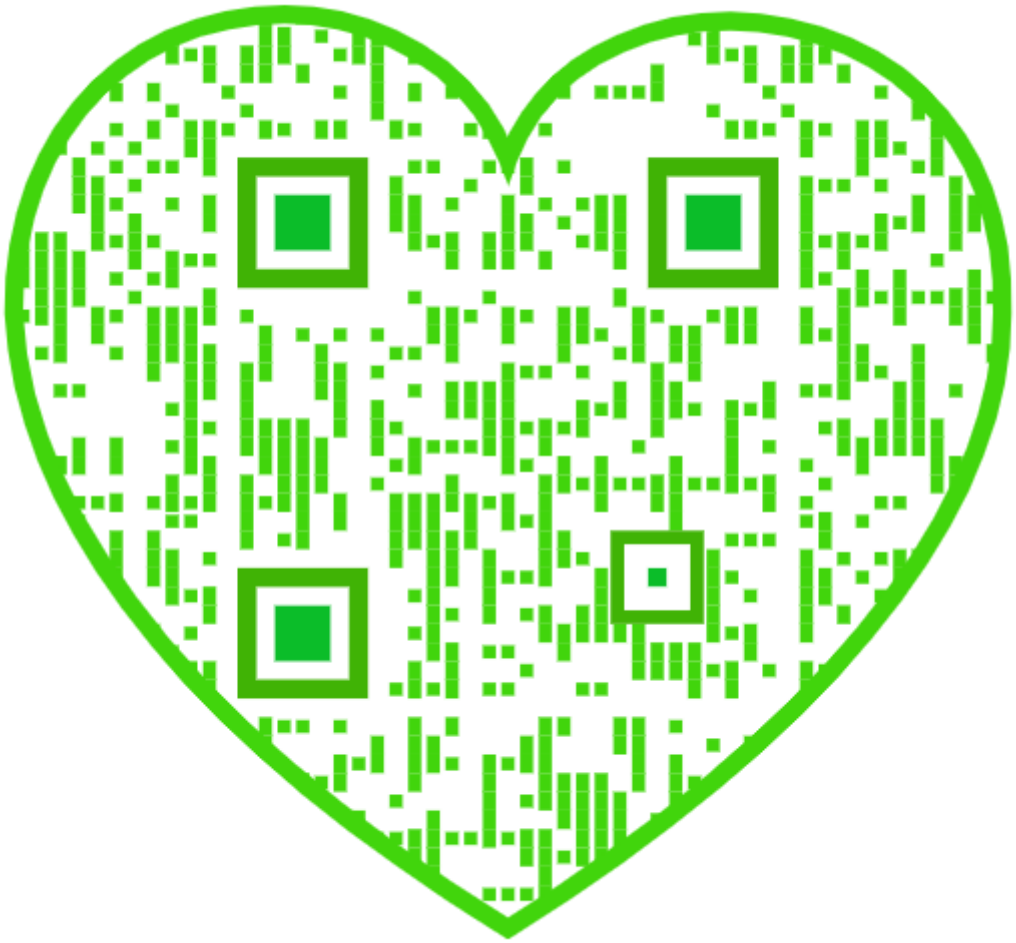


THERAPEUTICS II

SUBCOURSE MD0805 EDITION 200





DEVELOPMENT

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CLARIFICATION OF TRAINING LITERATURE TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

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USE OF PROPRIETARY NAMES

The initial letters of the names of some products are capitalized in this subcourse. Such names are proprietary names, that is, brand names or trademarks. Proprietary names have been used in this subcourse only to make it a more effective learning aid. The use of any name, proprietary or otherwise, should not be interpreted as an endorsement, deprecation, or criticism of a product; nor should such use be considered to interpret the validity of proprietary rights in a name, whether it is registered or not.

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COURRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0805

THERAPUTICS II

INTRODUCTION

In Subcourse MD0804, Therapeutics I, the basics of pharmacology were reviewed. MD0804 stressed the identification and use of references pertaining to drug information. Furthermore, you were given specific information on eight specific categories of drugs.

Subcourse MD0805, Therapeutics II, is intended to give you a review of certain essential anatomical and physiological concepts important to pharmacology and to introduce six categories of drugs. The review of anatomy and physiology should help you gain a better understanding of how the drugs work in the body and how they produce the side effects that are commonly associated with their use.

Remember that this subcourse is not intended to be used as an authoritative source of drug information. New drugs are being discovered and new uses for existing drugs are being found through research. Therefore, you should rely on this subcourse to review concepts or to learn new information. You should then use other sources (see MD0804, Therapeutics I--lesson 1) to gain additional information which will help you to do your job in a better way.

Subcourse Components:

This subcourse consists of 10 lessons. The lessons are:

Lesson 1. Dermatological Agents.

Lesson 2. The Human Muscular System.

Lesson 3. Skeletal Muscle Relaxants.

Lesson 4. Analgesic, Anti-inflammatory, and Antigout Agents.

Lesson 5. Review of Ocular and Auditory Anatomy and Physiology.

Lesson 6. Review of the Autonomic Nervous System.

Lesson 7. Adrenergic Agents.

Lesson 8. Adrenergic Blocking Agents.

Lesson 9. Cholinergic Agents.

Lesson 10. Cholinergic Blocking Agents (Anticholinergic Agents).

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

Upon successful completion of the examination for this subcourse, you will be awarded 14 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Section at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

LESSON ASSIGNMENT

LESSON 1	Dermatological Agents.
TEXT ASSIGNMENT	Paragraphs 1-1 through 1-5.
LESSON OBJECTIVES	1-1. Given a group of definitions and one of the following terms: dermatological agent, antiseborrheic agent, astringent, keratolytic agent, or keratoplastic agent, select the definition of that term.
	1-2. Given a group of statements, select the statement that best describes a general consideration pertaining to dermatological agents.
	1-3. Given a group of statements and the name of a particular category of dermatological agents, select the statement which best describes a general consideration or indication of that particular category.
	1-4. Given the trade or generic name of a dermatological agent and a list of trade and/or generic names, select the agent's corresponding name.
	1-5. Given the generic and/or trade name of a dermatological agent and a group of statements, select the statement which best describes the indication, use, or side effect associated with that agent.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

DERMATOLOGICAL AGENTS

Section I. BACKGROUND INFORMATION

1-1. DEFINITION OF DERMATOLOGICAL AGENTS

Dermatological agents are drugs that exert either a chemical or physical action on the skin to aid in the correction of a disorder of the skin.

1-2. GENERAL CONSIDERATIONS INVOLVING DERMATOLOGICAL AGENTS

a. The vehicles (creams, lotions, ointments, and so forth.) in which therapeutic ingredients are incorporated and diluted have been found to have pharmacological properties of their own. This subcourse will not mention these pharmacological properties of the vehicles. Instead, it will focus strictly on the pharmacological actions and effects of the therapeutic ingredients.

b. There is a great variation in the manner in which vehicles hold, release, or assist in the absorption of their therapeutic ingredients. Therefore, it is important that the vehicle selected to contain a therapeutic ingredient be suitable for use on the portion of skin on which it will be applied.

c. The even distribution of the therapeutic ingredient(s) throughout a vehicle is an important factor in the determination of a dermatological's effectiveness. You must be aware of this fact because you might one day be required to compound or manufacture some of the dermatological products discussed in this subcourse.

Section II. THERAPEUTIC CATEGORIES OF DERMATOLOGICAL AGENTS

1-3. ANTISEBORRHEICS

a. **Definition.** Antiseborrheics are used in the management of seborrheic dermatitis. Seborrheic dermatitis is characterized by a yellowish and greasy scaling of the scalp and/or mid-parts of the face (around eyebrows and nose) and ears.

b. **General Considerations.** The ideal antiseborrheic agent should be nontoxic, relieve pruritus (itching), modify excessive dryness, and demonstrate wide antifungal and antibacterial spectra.

c. **Specific Antiseborrheic Agents.**

(1) Chloroxine (Capitrol®). This agent is used in the treatment of dandruff and seborrheic dermatitis of the scalp. The patient should be instructed not to use this medication if blistered, raw, or oozing areas are present on the scalp and to keep the medication away from the eyes. This medication may slightly discolor light-colored hair.

(2) Selenium sulfide (Selsun®). This shampoo product is used to treat dandruff and seborrheic dermatitis of the scalp. The patient should be instructed not to use this medication if blistered, raw, or oozing areas are present on the scalp and to keep the medication away from the eyes. This medication should be thoroughly rinsed from the hair of persons with light-colored hair because it can cause discoloration.

(3) Sebulex® or Sebra® Shampoo. This product is made of salicylic acid (2%) and sulfur (2%). It is used as a shampoo to treat seborrheic dermatitis, dandruff, and psoriasis of the scalp. Present in these concentrations, salicylic acid and sulfur are used for their keratoplastic (mild keratolytic) actions. The patient using this product should be informed of two things. One, this product may discolor light-colored hair. Two, the patient should not use this product on the same area to which has been applied any topical mercury-containing product (such as ammoniated mercury ointment) because doing so might stain that area of skin and produce a foul odor (interaction between sulfur and mercury).

(4) Sebutone® or Sebra T® Shampoo. This product is made of salicylic acid (2%), coal tar (0.5%), and sulfur (2%). In these concentrations, the salicylic acid and sulfur are used for their keratoplastic (mild keratolytic) actions, and coal tar is used for its antipruritic (controls itching), antibacterial, and keratoplastic actions. The patient using this product should be informed of two things. One, this product may discolor light-colored hair. Two, the patient should not use this product on the same area to which has been applied any topical mercury-containing product (such as ammoniated mercury ointment) because doing so might stain that area and produce a foul odor.

1-4. ASTRINGENTS

a. **Definition.** An astringent is an agent that dries mucous secretions, shrinks skin, and causes blanching (whitening).

b. **Indications for the Use of Astringents.** Astringents are used to reduce inflammation of mucous membranes, to promote healing, and to toughen skin.

c. **Specific Astringent Agents**.

(1) Aluminum acetate tablets (Domeboro®, Burow's solution). When these tablets are added to water, aluminum acetate solution is prepared. This product is used as an astringent for inflammatory skin conditions such as insect bites, poison ivy, and athlete's foot. The patient receiving these tablets should be warned that they are for external use only. The patient should be told to see his physician if the inflammatory condition does not improve and to avoid getting the prepared solution in contact with his eyes. Usually one or two of the tablets are dissolved in a pint of water. The patient is then to soak the affected area two or three times daily in the freshly prepared solution for 15 minutes.

(2) Calamine lotion (calamine and zinc oxide lotion). This product is used as an astringent and as a protectant (used to cover and protect epithelial surfaces). Both these actions aid in reducing inflammation associated with insect bites, poison ivy, and sunburn. The patient receiving this product should be told that the preparation is for external use only and that he should shake the product well before using it.

(3) Phenolated and mentholated calamine lotion. Phenol and menthol have been added to calamine lotion (calamine and zinc oxide lotion) because they produce an antipruritic effect.

1-5. KERATOLYTICS

a. **Definition**. A keratolytic is an agent that induces sloughing of cornified epithelium (horny or hard layer of the skin).

b. **General Considerations**. Keratolytic drugs act to damage the cornifled layer of skin that is then sloughed off to whatever depth the agent has acted. A keratoplastic (mild keratolytic) effect is seen when the drug does not produce a rapid destruction and sloughing, thereby softening the keratin and loosening the cornified epithelium.

c. **Indications for the Use of Keratolytic Agents**. Keratolytic agents are used to remove warts and corns. They are also used in the treatment of severe acne.

d. **Indications for the Use of Keratoplastic Agents**. Keratoplastic agents are used in the treatment of acne, eczema, psoriasis, and seborrheic dermatitis.

e. **Specific Keratolytic Agents**.

NOTE**:** You will see chemicals (1) through (4) present in several manufactured products. You might be called upon to compound or manufacture products containing one or more of these substances. If you handle these chemicals, remember that they are irritating to the skin. You should wash your hands immediately after working with them.

(1) Coal tar (chemical name). This agent is used as a keratoplastic in the treatment of eczema, psoriasis, and seborrheic dermatitis.

(2) Salicylic acid (chemical name). It is used as a keratolytic when present in concentrations of from 5% to 20%. It is used as a kerato- plastic when present in concentrations of from 1% to 2%.

(3) Sulfur (chemical name). Sulfur is used as a keratoplastic in the treatment of acne and seborrheic dermatitis.

(4) Tretinoin (topical) (Retin A®). This agent is used in the treatment of severe acne. The application of this agent to the skin will produce a horny layer of skin that is more easily removed. It is important that the patient use this preparation as directed by the physician and package directions. This medicine should not be applied to windburned or sunburned skin. It should not be applied to open wounds. Furthermore, the medication should not be applied inside the nose, around the eyes, or around the mouth. While the patient is using the medication, he should avoid exposing the area being treated to too much wind or sun (or sun lamp). When the patient begins using this product, he may find that he is more sensitive to cold temperatures and to wind than before; therefore, protection should be worn until the person sees how he reacts. This product is available in cream, liquid, and gel.

(5) Salicylic acid 2% and sulfur 2% (Fostex®). This preparation is available in cream or soap. It is used to treat acne.

(6) Salicylic acid 2% and Sulfur 2% shampoo (Sebulex® or Sebra®). This shampoo is used to treat dandruff.

(7) Salicylic acid 2%, coal tar 0.5%, and sulfur 2% shampoo (Sebutone® or Sebra T®). This product is used to treat dandruff.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson, and, check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which of the following is the definition of antiseborrheic agent?

   a. An agent that dries mucous secretions, shrinks skin, and causes blanching.

   b. An agent used to manage a skin condition characterized by a yellowish and greasy scaling of the scalp and/or mid-parts of the face and ears.

   c. An agent used in the treatment of severe acne and in the removal of warts or corns.

   d. An agent used in the treatment of acne, eczema, and psoriasis.

2. Which of the following statements best describes a general consideration associated with the use of keratolytic agents?

   a. These agents are not to be used on mucous membranes.

   b. These agents sometimes produce a yellowish and greasy scaling around the mid-parts of the face when they are applied as a treatment for acne.

   c. These agents usually make a person excessively sensitive to the effects of cold and wind.

   d. These agents are used to damage the cornified layer of skin so that it will be sloughed off.

3. Which of the following is the correct use of Burow's solution?

   a. An astringent for inflammatory skin conditions.

   b. An agent used in the treatment of seborrheic dermatitis.

   c. An agent used in the treatment of eczema.

   d. An astringent used in the treatment of warts and corns.

4. **SPECIAL INSTRUCTIONS:** Match the generic name in Column A with its corresponding trade name in Column B.

	Column A	Column B
A.	Salicylic acid 2% and sulfur 2% soap	_____ Fostex®
B.	Selenium sulfide	_____ Retin A®
C.	Tretinoin	_____ Selsun®
D.	Aluminum acetate tablets	_____ Capitrol®
E.	Coal tar	_____ Burow's solution

5. What information you should give a patient who has been prescribed selenium sulfide shampoo for the first time?

   a. "You should wear some sort of protection because you might be more sensitive to cold temperatures and to wind."

   b. "You should not use this medication if you have applied any medicine containing mercury on your scalp."

   c. "You should not use this medication if your scalp is raw or blistered."

   d. "You should stop using this medication if your scalp condition has not improved within five days."

6. What information you should give to a person who has been prescribed aluminum acetate tablets for the first time?

   a. “These tablets are not to be taken by mouth. Instead, make a solution as prescribed on the container label and use the prepared solution as a soak.”

   b. “Do not be alarmed if your hair turns slightly orange for a few days after you use this product.”

   c. “Do not expose the portion of your body you are soaking in the prepared solution to sunlight or wind.”

   d. “Do not use the solution you prepare from these tablets on any part of your body to which has been applied any medication containing mercury."

7. Which of the following is the correct use of coal tar?

   a. A keratoplastic agent used in the treatment of eczema, psoriasis, and seborrheic dermatitis.

   b. A keratolytic agent used in the treatment of severe acne.

   c. An astringent used in the treatment of acne and seborrheic dermatitis.

   d. A product used as a protectant and astringent in the treatment of inflammation associated with insect bites and sunburn.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. b (para 1-3a)

2. d (para 1-5b)

3. a (para 1-4c(1))

4. A Fostex® (para 1-5e(5))
   C Retin A® (para 1-5e(4))
   B Selsun® (para 1-3c(2))
   E Capitrol® (para 1-3c(1))
   D Burow's Solution (para 1-4c (1))

5. c (para 1-3c(2))

6. a (para 1-4c(1))

7. a (para 1-5e(1))

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2 The Human Muscular System.

TEXT ASSIGNMENT Paragraphs 2-1 through 2-4.

LESSON OBJECTIVES

2-1. Given a group of definitions and one of the following terms: dermatological agent, antiseborrheic agent, astringent, keratolytic agent, or keratoplastic agent, select the definition of that term.

2-2. Given a list of properties, select the properties of muscle tissue.

2-3. Given one of the properties of muscle tissue and a group of statements, select the statements that best describe that property.

2-4. From a list, select the types of muscle tissue found in the human body.

2-5. Given the name of a type of muscle tissue found in the body and a group of statements, select the statement that best describes the physiology of that type of tissue.

2.6. Given the name of a type of muscle tissue found in the body and a group of statements, select the statement that best describes the physiology of that type of tissue.

2-7. Given a statement relating to muscle physiology and a list of the types of muscle tissue, select the type of muscle tissue to which the statement applies.

SUGGESTION After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

THE HUMAN MUSCULAR SYSTEM

2-1. BACKGROUND

Muscular tissue is useful to the body because it contracts and thereby produces movement. The contraction of striated muscle attached to bone results in movement of the skeleton. Cardiac muscle contracts rhythmically and acts as a pump to move blood through the cardiovascular system. The contraction of smooth or visceral muscle results in the movement of materials inside the body, such as the propulsion of food through the digestive tract.

2-2. TERMS ASSOCIATED WITH THE HUMAN MUSCULAR SYSTEM

a. **Motor Unit**. A motor unit is a single motor neuron and the number of striated muscle fibers activated by it (innervation). The importance of the motor unit is that its fibers work in unison.

b. **Tonus**. Tonus is defined as a slight continuous contraction of muscle tissue that aids in the maintenance of posture and in the return of blood to the heart.

c. **All or None Law.** Under the influence of nervous stimulation, a single muscle fiber will always contract to its maximum capacity.

2-3. PROPERTIES OF MUSCLE TISSUE

Muscles have certain key properties.

a. **Irritability.** Irritability refers to the ability of a muscle to respond to a stimulus.

b. **Contractability.** Contractability refers to the muscle's ability to shorten in length.

c. **Extensibility**. Extensibility refers to a muscle's ability to extend in length.

d. **Elasticity**. Elasticity refers to a muscle's ability to stretch and return to its normal position.

2-4. TYPES OF MUSCLE TISSUE

a. **Skeletal Muscle.** Each skeletal muscle is an individual organ of the human body. Each is composed of several types of tissues, mainly striated muscle fibers, and fibrous connective tissue (FCT). Each is attached to and moves bones. Bones are parts of the skeleton serving as levers. The large portion of a muscle is known as its belly or fleshy belly. The muscle is attached to bones by tendons or aponeuroses. Tendons and aponeuroses are similar to each other. However, tendons are cord-like, and aponeuroses are broad and flat. The fleshy portion may be directly connected to the bone. If it is attached to the bone, it is called a "fleshy attachment."

(1) Anatomy. The muscle cells of skeletal muscles are elongated and are called fibers. The fibers of the skeletal muscles are striated (a striped appearance) to give strength. Movement of the skeleton, such as lifting a leg, is voluntary, as are all of the movements characterized by the skeletal system.

(2) Physiology. The neuromuscular junction consists of a nerve fiber and a skeletal muscle fiber. The nerve fiber is branched at the end to form a structure called the end plate. This end plate invaginates into the muscle fiber, but it always stays outside the membrane of the muscle. The sole feet are located at the tips of the numerous branches of the end plate. The space between the fiber membrane and the sole foot are referred to as the synaptic cleft. A gelatinous substance fills the synaptic cleft. Mitochondria that supposedly synthesize the substance acetylcholine are located in the sole foot. Numerous small vesicles (bags) serve as storage locations for acetylcholine. The enzyme cholinesterase, which is used to destroy acetylcholine, is also found in the area of the synaptic cleft.

(a) Secretion of acetylcholine. The vesicles release acetylcholine when a nerve impulse reaches the neuromuscular junction. Shortly after the acetylcholine is released (around two milliseconds), it diffuses and no longer has any effect upon the muscle. During the short time, the acetylcholine produces its effects upon the muscle; the muscle becomes very permeable to sodium ions (Na^+). Because of the influx of sodium ions into the muscle, the electrical potential of the membrane increases. Hence, the muscle fiber is stimulated. Figure 2-1 illustrates the contraction of skeletal muscle.

(b) Destruction of acetylcholine. Shortly after the acetylcholine is released, cholinesterase begins to destroy it. Such a rapid destruction of the acetylcholine prevents it from re-stimulating the muscle until another nerve impulse reaches the neuromuscular junction. Figure 2-2 illustrates the relaxation of the muscle tissue.

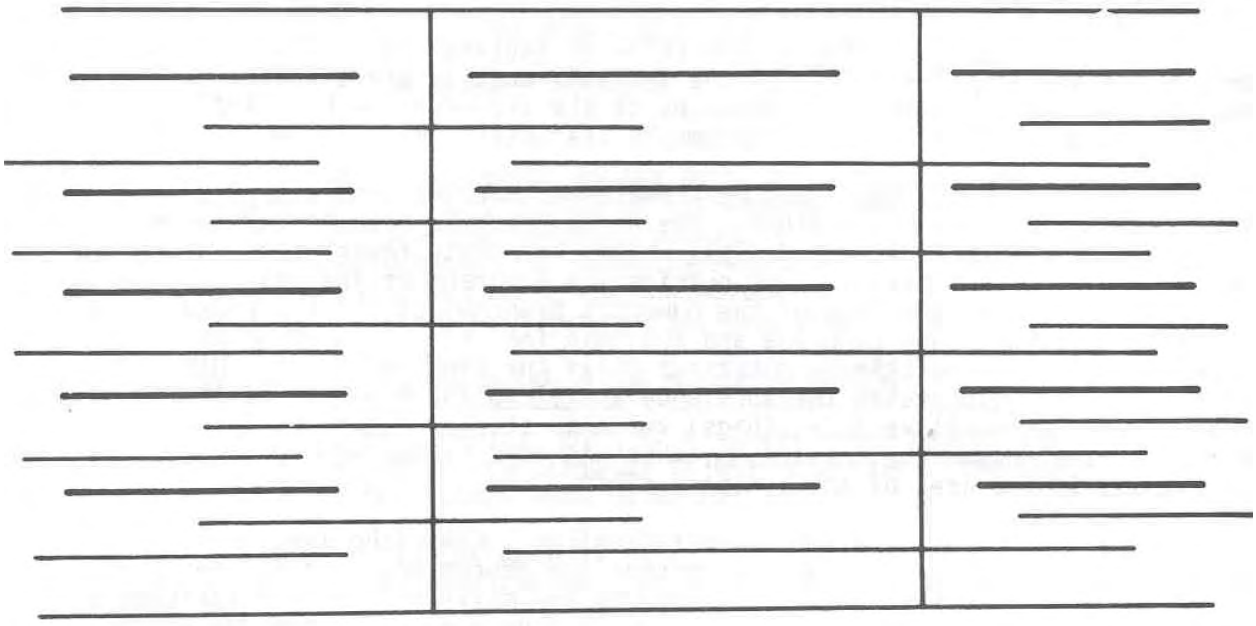

Figure 2-1. Contracted skeletal muscle.

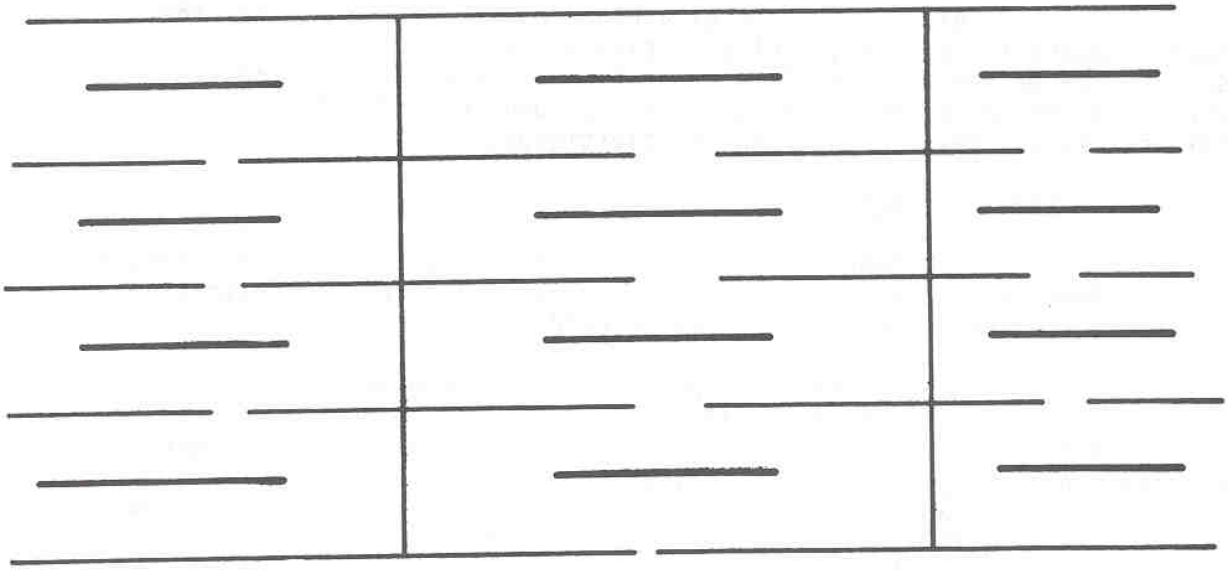

Figure 2-2. Relaxed skeletal muscle.

(3) Disorders.

(a) Muscle cramps. Muscle cramps are persistent involuntary contractions of the skeletal muscles. Muscle cramps can be caused by over-exercise, lack of blood flow, or severe cold.

(b) Myasthenia gravis. Myasthenia gravis is a major disorder of the skeletal muscle system. Muscle weakness and excessive fatigue characterize it. In myasthenia gravis, the muscular system is marked by progressive paralysis of the muscles, which is caused by an abnormal condition at the neuromuscular junction due to a lack of acetylcholine or an excess of cholinesterase. If there is either too little acetylcholine or an excess of cholinesterase, a contraction will not occur.

b. **Cardiac Muscle.** The muscles of the heart are called cardiac muscles.

(1) Anatomy. Cardiac muscle is made up of branched, striated fibers and responds to stimuli as if it were a single muscle fiber. Cardiac tissue is responsible for the propulsion of blood through the circulatory system. The contraction and relaxation of the heart move the blood.

(2) Physiology. In order for an individual to live (without the assistance of life-support equipment), his heart must never stop beating. Cardiac muscle must maintain a steady rhythm and not become fatigued. Cardiac muscle does not become fatigued because it can use both glucose and lactic acid, its waste product. The contraction of the cardiac muscle is involuntary and does not directly respond to any nervous stimulation. This property is referred to as inherent rhythmicity. The heart rate may be modified by the autonomic nervous system. Sympathetic or adrenergic stimulation will increase heart rate and parasympathetic or cholinergic stimulation will decrease heart rate. To ensure rhythmical contractibility, cardiac muscle must be supplied with appropriate ions in proper concentrations. These ions are supplied in the blood. Too little sodium leads to weak and rapid heart contractions. Too much potassium makes the cardiac muscle cells lose their excitability and complete heart blockage can occur. Excessive levels of calcium in the blood can lead to increased contractibility of the cardiac muscle. Extremely high levels of the calcium ion in the heart tissue can cause the heart to remain in a state of contraction.

(3) Disorders. An irregular heart beat pattern is called an arrhythmia. There are different types of cardiac arrhythmias (that is, flutter or fibrillation). Arrhythmias can sometimes be treated with drugs. More specific information on arrhythmias and the drugs used to treat them will be given to you in another subcourse (MD0806, Therapeutics III).

c. **Smooth Muscle.** All muscles that are not found in the heart or are not attached to the skeletal system are called smooth muscles.

(1) Anatomy. The fibers of smooth muscles are elongated and nonstriated. The size of the fiber varies with the location of the muscle. For example, the smallest smooth muscles are found in the blood vessels and the largest are found in the digestive tract. Smooth muscle is responsible for such important functions as peristalsis, blood pressure, and air volume. Peristalsis is the rhythmic wave-like motion of the alimentary canal and other tubular organs caused by waves of contraction passing along the smooth muscle in the tube. Smooth muscle is involved in blood pressure by altering the diameter of blood vessels. It is involved in the control of air volume by altering the diameter of the bronchial tubes. Smooth muscle contracts involuntarily-it is an unconscious act.

(2) Physiology. The same chemical substances are found in smooth muscle as are found in skeletal muscle. Contraction of smooth muscle tissue occurs by the activation by ions--just the same as with skeletal muscles: Contraction occurs during depolarization of the muscle membrane, and it stops after repolarization. Smooth muscle tissue does not contract as rapidly as skeletal muscle tissue. Furthermore, the relaxation of the smooth muscle following contraction is likewise slower than in skeletal muscle. Smooth muscle is capable of maintaining tonic contractions over a long period of time. Smooth muscle can undergo changes in length without significant change in tension. This is called stress-relaxation.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson, and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. The term tonus is best defined as:

   a. The process by which all muscle fibers always contract to their maximum capacity.

   b. The ability of a muscle to stretch and return to its normal position.

   c. A slight continuous contraction of muscle tissue which aids in the maintenance of posture and in the return of blood to the heart.

   d. The ability of a muscle fiber to contract and expand in order to meet the requirements of extension.

2. Which of the following is a property of muscle tissue? (More than one response may be correct.)

   a. Irritability.

   b. Malleability.

   c. Extensibility.

3. Elasticity, one of the properties of muscle tissue, is best defined as:

   a. The ability of a muscle to stretch and return to its normal position.

   b. The ability of a muscle to shorten in length.

   c. The ability of a muscle to respond to a stimulus.

   d. The ability of a muscle to extend in length.

4. Which of the following is a type of muscle tissue found in the human body? (More than one response may be correct.)

   a. Skeletal muscle tissue.

   b. Adipose muscle tissue.

   c. Cardiac muscle tissue.

   d. Smooth muscle tissue.

5. Which of the following statements best describes skeletal muscle?

   a. Muscle tissue that is made up of branched, striated fibers and responds to stimuli as if it were a single muscle fiber.

   b. Muscle fibers that are striated and elongated.

   c. Muscle fibers that are elongated and non-striated.

   d. Muscle tissue which is branched and striated and is found in the alimentary canal.

6. Which of the following statements best describes the physiology involved with cardiac muscle tissue?

   a. The contraction is involuntary and does not respond directly to any nervous stimulation.

   b. In this tissue, relaxation occurs during depolarization of the muscle membrane and stops after repolarization.

   c. In this tissue, the chemical acetylcholine is released by the vesicles in the neuromuscular junction with a resultant influx of potassium ions into the muscle.

   d. The secretion of acetylcholinesterase near the neuromuscular junction produces the contraction of this type of tissue.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. c (para 2-2b)

2. a (para 2-3a)
   c (para 2-3c)

3. a (para 2-3d)

4. a (para 2-4a)
   c (para 2-4b)
   d (para 2-4c)

5. b (para 2-4a(1))

6. a (para 2-4b(2))

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3	Skeletal Muscle Relaxants.
TEXT ASSIGNMENT	Paragraphs 3-1 through 3-7.
LESSON OBJECTIVES	3-1. Given a group of definitions, select the definition of the term muscle relaxant.
	3-2. Given a group of statements, select the statement that best describes the mechanism of action of neuromuscular blocking agents.
	3-3. Given a group of statements, select the statement that best describes the process of normal nerve transmission.
	3-4. Given a list of uses, select the use of neuromuscular blocking agents.
	3-5. Given one of the two classifications of neuromuscular blocking agents and a group of statements, select the statement that best describes that classification's mechanism of action.
	3.6. Given a group of statements, select the statement that best describes the mechanism of action of centrally-acting skeletal muscle relaxants.
	3-7. Given the trade or generic name of a skeletal muscle relaxant and a list of trade or generic names select the appropriate name of that particular drug.
	3-8. Given the trade or generic name of a skeletal muscle relaxant and a group of uses or side effects, select the use or side effect of that agent.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

SKELETAL MUSCLE RELAXANTS

Section I. GENERAL

3-1. BACKGROUND

Some Indian tribes in South America have used muscle relaxants for centuries. They have used curare, a potent muscle relaxant, to kill game and to protect themselves because of curare's ultimate pharmacological effect-death. Today, anesthesiologists use this agent to relax skeletal muscles in some surgical procedures. This lesson will focus on skeletal muscle relaxants and their use in modern medicine.

3-2. DEFINITION OF A MUSCLE RELAXANT

A skeletal muscle relaxant may be defined as an agent that reduces skeletal muscle tone. Even when muscles are at rest, there is a certain amount of tension or tautness that is present. This remaining degree of contraction of skeletal muscle is called skeletal muscle tone. It is believed that skeletal muscle tone results entirely from nerve impulses originating from the spinal cord. If these nerve impulses are blocked in some manner, the result is decreased skeletal muscle tone: skeletal muscle relaxation. The degree of skeletal muscle relaxation ranges from partial to complete depending upon the effectiveness of the skeletal muscle relaxant being used and its site of activity.

Section II. THE NEUROMUSCULAR BLOCKING AGENTS

3-3. MECHANISM OF ACTION

a. The neuromuscular blocking agents act by blocking the action of acetylcholine (Ach) at the neuromuscular junction or at the muscle receptor site.

b. What occurs at the neuromuscular junction during normal nerve transmission? The nerve impulse enters the terminal knob, and the neurotransmitter acetylcholine (Ach) is released and attaches to appropriate receptor sites on the muscle receptor site, much like a lock and key (figure 3-1). When Ach attaches, there is a great influx of sodium into the muscle receptor site, and potassium flows out. This causes the receptor site to depolarize; therefore, muscle contraction results.

c. The Ach does not remain in the receptor sites forever. When it releases, it is destroyed by acetylcholinesterase (Ache). The resultant release causes an influx of potassium back into the muscle receptor site, and sodium is pumped out. The nerve that stimulates the muscle receptor site repolarizes and returns to normal. Because of repolarization, the skeletal muscle relaxes.

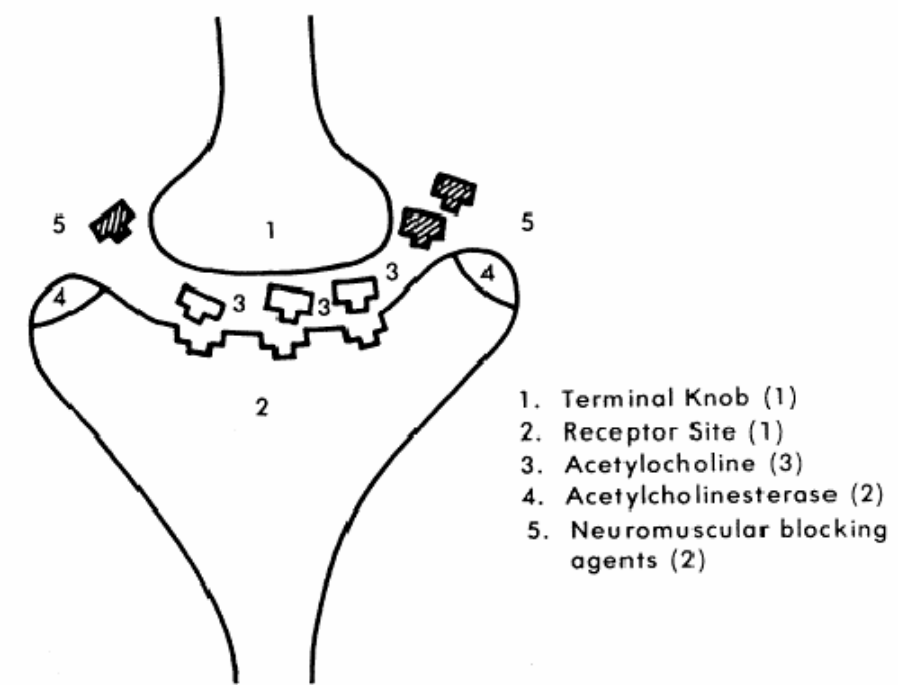

Figure 3-1. Muscle depolarization.

3-4. USE OF THE NEUROMUSCULAR BLOCKING AGENTS

The neuromuscular blocking agents are used with general anesthetics to provide sustained muscle relaxation. This sustained muscle relaxation reduces the tone of the skeletal muscles (that is makes them flaccid or flabby) during surgical procedures. Because of this skeletal muscle relaxation, the surgeon can easily cut through the muscle.

3-5. CLASSIFICATION OF THE NEUROMUSCULAR BLOCKING AGENTS

The neuromuscular blocking agents are classified as either non-depolarizing agents or depolarizing agents.

a. The non-depolarizing agents compete with the neurotransmitter, acetylcholine, for the muscle receptor site. Therefore, they prevent depolarization. This produces flaccid paralysis of the skeletal muscles for a period of about one hour-depending upon the concentration of the agent administered. The non-depolarizing blocking agents are often referred to as competitive neuromuscular blocking agents. Examples of non-depolarizing blocking agents are curare, Norcuron® (vecuronium), Pavulon® (pancuronium), and Nimbex® (cisatricurium).

(1) Curare. Curare is used to produce a complete skeletal muscle relaxation or flaccid paralysis of skeletal muscle during general anesthesia and other procedures. It is a potentially dangerous drug for obvious reasons: Too much of a drug administered too quickly can result in paralysis of the muscles that control respiration. The primary side effects associated with curare are bradycardia and hypotension. The individual responsible for administering the curare during anesthesia must monitor the vital signs of the patient to ensure that the patient does not experience toxic effects from the curare. That person will also have to ensure that the patient is able to breathe (sometimes mechanical assistance is required) when curare is administered since curare relaxes all the skeletal muscles of the body, and the patient sometimes finds difficulty in breathing. Curare is supplied in an injectable form.

(2) Pancuronium (Pavulon®). Pancuronium is five times more potent than curare and it produces complete skeletal muscle relaxation. It poses the same risk factors for the patient as does curare. The primary side effects seen with pancuronium are cardiac arrhythmias of various types.

b. The depolarizing blocking agents act like an excess of acetylcholine to depolarize the muscle receptor site and prevent its repolarization. Thus, there is an initial depolarization at the neuromuscular junction producing muscle contraction; but since the muscle receptor site cannot depolarize, complete skeletal muscle relaxation follows. In general, the relaxation effects produced by the depolarizing agents are of shorter duration than the relaxation produced by the non-depolarizing agents.

(1) Succinylcholine (Anectine®). Succinylcholine is a depolarizing agent used to produce complete muscle relaxation for various surgical procedures. The primary side effects associated with succinylcholine are cardiac arrhythmias and post-operative apnea (temporary stoppage of breathing).

(2) Decamethonium bromide (Syncurine®). Decamethonium bromide is used as a muscle relaxant for relatively short surgical procedures. Side effects associated with this agent include muscle soreness, respiratory depression, and prolonged apnea.

Section III. CENTRALLY ACTING SKELETAL MUSCLE RELAXANTS

3-6. BACKGROUND

Centrally acting skeletal muscle relaxants are so called because they act on the central nervous system to decrease muscle tone. They decrease muscle tone by depressing the internuncial neurons at the spinal cord (figures 3-2 and 3-3). When given in normal therapeutic doses, these agents are not potent enough to produce flaccid paralysis. However, large oral or injectable doses of these drugs may produce hypotension, flaccid paralysis, and respiratory depression. Many of these drugs are similar in chemical structure to antianxiety agents. These agents are used to relieve skeletal muscle spasms. Whether relief of pain achieved by patients taking these drugs is due to their muscle relaxant effect or to their sedative effect is unknown.

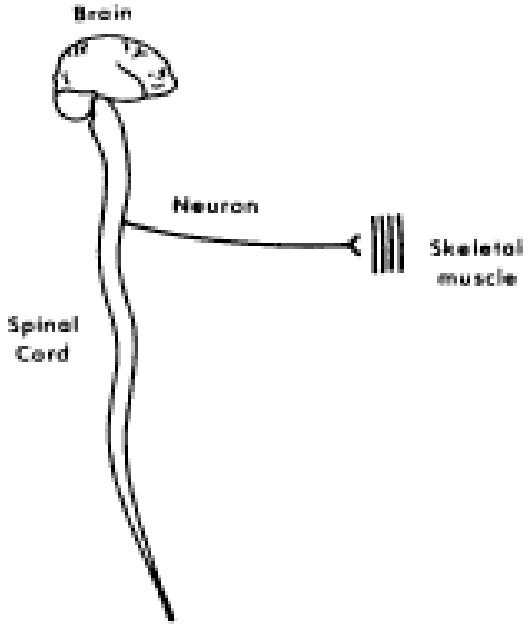

Figure 3-2. The somatic nervous system.

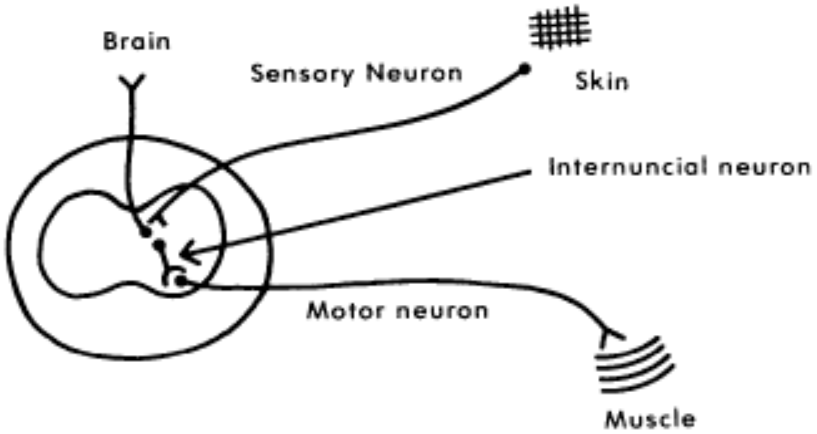

Figure 3-3. Cross section of spinal cord showing internuncial neuron.

3-7. EXAMPLES OF CENTRALLY ACTING SKELETAL MUSCLE RELAXANTS

a. **Diazepam (Valium®).** Diazepam is an antianxiety agent that is also used as a skeletal muscle relaxant in a dosage of from 2 to 10 milligrams three or four times daily. The main side effect of diazepam is central nervous system depression. The patient taking diazepam should be warned that the drug might cause drowsiness. Furthermore, the patient should be warned not to drink alcoholic beverages while taking diazepam. Diazepam is a controlled substance (Note Q).

b. **Cyclobenzaprine (Flexeril®).** This skeletal muscle relaxant is usually given in a dosage of between 20 to 40 milligrams in 2 to 4 divided doses on a daily basis. Central nervous system depression is the primary side effect of this drug. The patient taking cyclobenzaprine should be warned that he might experience drowsiness because of the drug. He should also be warned not to drink alcoholic beverages while taking the drug. This agent is supplied in tablet form.

c. **Orphenadrine Citrate (Norflex®).** This skeletal muscle relaxant is given in a dosage of 100 milligrams twice daily. The drug causes central nervous system depression. The patient should be warned that he might become drowsy while taking the drug. Furthermore, the patient should be warned not to drink alcoholic beverages while taking Norflex®. Norflex® is available in tablet form.

d. **Chlorzoxazone (Paraflex®, Parafon Forte DSC®).** This skeletal muscle relaxant is used as an adjunct to rest, physical therapy, and other measures to relieve the discomfort associated with acute, painful musculoskeletal conditions. It does not directly relax tense muscles. Chlorzoxazone has some antianxiety properties and causes some CNS depression. The patient taking this medication should be warned of the potential drowsiness and should not drink alcohol while taking this medication. The usual adult dosage is 250 mg three or four times a day. Initial dosage for painful musculoskeletal conditions is 500 mg three or four times daily and increased to 750 mg three or four times daily if needed. Chlorzoxazone is supplied as 250-mg tablets (Paraflex®) and 500-mg tablets (Parafon Forte DSC®).

e. **Methocarbamol (Robaxin®).** Methocarbamol is a skeletal muscle relaxant which is usually administered in a dosage of 1 gram four times daily for muscle spasms. Since it can produce central nervous system depression, the patient should be warned of the drowsiness that could accompany its use. When administered intravenously, methocarbamol is used to treat acute muscle spasms associated with trauma and inflammation. Methocarbamol is also used in producing skeletal muscle relaxation for orthopedic procedures when it is administered intravenously.

f. **Dantrolene (Dantrium®).** Dantrolene is a skeletal muscle relaxant that reduces skeletal muscle tone through a direct effect on muscle contraction. It is believed that dantrolene affects the uptake of calcium by muscle tissue. This drug is used to relieve the muscle spasticity associated with such diseases as multiple sclerosis or cerebral palsy. It is given in oral form initially in a dose of 25 milligrams once or twice daily; the dosage of the drug is then increased in increments until the desired therapeutic effect is attained. Although it does not produce its effects on the central nervous system like the other oral skeletal muscle relaxants, it may cause drowsiness. You should warn the patient about this potential drowsiness. Dantrolene may also cause nausea and vomiting. Dantrolene is used in the treatment of malignant hyperthermia.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson, and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which of the following is the best definition of the term "muscle relaxant"?

   a. An agent that prevents the transmission of any nerve impulses.

   b. An agent that causes a patient to become less anxious.

   c. An agent that reduces skeletal muscle tone.

   d. An agent that causes muscles to be relaxed because it increases the amount of acetylcholine present at the neuromuscular junction.

2. Which of the following statements best describes the mechanism of action of neuromuscular blocking agents?

   a. They decrease muscle tone by depressing the internuncial neurons at the spinal cord.

   b. They block the action of acetylcholine at the neuromuscular junction or at the muscle receptor site.

   c. They act on the terminal knob to cause a release of acetylcholine at the neuromuscular junction to produce the depolarization of the receptor site.

   d. They cause a great influx of sodium into the muscle receptor site and a great influx of potassium out of the receptor site in order to make the muscle become relaxed.

3. Centrally acting skeletal muscle relaxants act by:

   a. Decreasing the muscle tone by depressing the internuncial neurons at the spinal cord.

   b. Blocking the action of acetylcholine at the neuromuscular junction or the muscle receptor site.

   c. Causing the sodium and potassium at the receptor site to flow into and out of the area.

   d. Destroying the acetylcholine at the neuromuscular junction.

4. Match the generic names in Column I with the appropriate trade name in Column II.

Column I		Column II
_____	Cyclobenzaprine	A. Flexeril®
_____	Pancuronium	B. Parafon Forte DSC®
_____	Orphenadrine citrate	C. Anectine®
_____	Succinylcholine	D. Pavulon®
_____	Chlorzoxazone	E. Norfiex®
		F. Syncurine®
		G. Dantrium®

5. Which of the following is the use for decamethonium bromide?

   a. Used to produce complete muscle relaxation during general anesthesia.

   b. Used to calm or relax a patient prior to surgery.

   c. Used to relieve muscle spasms.

   d. Used as a muscle relaxant for relatively short procedures.

6. The patient taking Parafon Forte DSC® should be warned:

   a. Not to drink alcoholic beverages while taking the drug.

   b. That the drug may produce muscle spasms if taken in excess.

   c. That the drug may produce hypertension and bradycardia.

   d. That the drug may produce cardiac arrhythmias.

7. The person who administers curare during general anesthesia must carefully observe the patient because curare might produce:

   a. Cardiac arrhythmias.

   b. Too deep a level of analgesia in a patient.

   c. Respiratory depression.

   d. Tachycardia.

8. The patient taking orphenadrine citrate should be warned that:

   a. He may become drowsy while taking the drug.

   b. The drug may produce skeletal muscle relaxation.

   c. He may experience cardiac arrhythmias.

   d. The drug may produce tachycardia.

9. Methocarbamol (Robaxin®) when administered intravenously is used to treat:

   a. Multiple sclerosis and cerebral palsy.

   b. Hypercalcemia.

   c. Trauma.

   d. Acute muscle spasms associated with trauma and inflammation.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. c (para 3-2)

2. b (para 3-3a)

3. a (para 3-6)

4. A Cyclobenzaprine (para 3-7b)
   D Pancuronium (para 3-5a(2))
   E Orphenadrine citrate (para 3-7c)
   C Succinylcholine (para 3-5b(1))
   B Chlorzoxazone (para 3-7d)

5. d (para 3-5b(2))

6. a (para 3-7d)

7. c (para 3-5a(1))

8. a (para 3-7c)

9. d (para 3-7e)

End of Lesson 3

LESSON ASSIGNMENT

LESSON 4	Analgesic, Anti-Inflammatory, and Antigout Agents.
TEXT ASSIGNMENT	Paragraphs 4-1 through 4-8.
LESSON OBJECTIVES	4-1. Given one of the following terms: analgesic, antipyretic, anti-inflammatory agent, rheumatism, arthritis, or gout, and a list of definitions select the definition of the given term.
	4-2. Given the trade or generic name of an analgesic, anti-inflammatory, or anti-gout agent and a list of trade and/or generic names, select the appropriate name for that agent.
	4-3. Given the trade and/or generic name of an analgesic, anti-inflammatory, or anti-gout agent and a group of statements pertaining to indications, use, side effects, or cautions and warnings, select the statement that best applies to that drug.
	4-4. Given a group of statements, select the statement that best describes the cause of gout.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 4

ANALGESIC, ANTI-INFLAMMATORY, AND ANTIGOUT AGENTS

Section I. BACKGROUND

4-1. INTRODUCTION TO ANALGESIC, ANTI-INFLAMMATORY, AND ANTI-GOUT AGENTS

Since the beginning of time, every civilization has sought a perfect medicinal agent that would relieve pain. As far back as the third century B.C., physicians were administering the juice of the opium poppy to patients for the relief of pain. Opium derivatives are still widely used in the treatment of severe pain. Fortunately, agents with less abuse potential have been discovered for the relief of pain. This lesson will focus on analgesics, anti-inflammatory, and anti-gout agents.

4-2. DEFINITIONS

a. **Analgesic**. An analgesic is an agent that relieves pain.

b. **Antipyretic**. An antipyretic is an agent that lowers elevated body temperature.

c. **Anti-Inflammatory Agent**. An anti-inflammatory agent is a drug that decreases inflammation.

d. **Rheumatism**. Rheumatism is a condition characterized by inflammation of connective tissue.

e. **Arthritis**. Arthritis is a form of rheumatism in which the inflammation is confined to body joints.

f. **Gout**. Gout is a form of arthritis that is caused by an excess of uric acid in the blood that periodically precipitates in the peripheral joints as monosodium urate.

Section II. ANALGESIC AGENTS

4-3. BACKGROUND

Analgesic agents relieve pain. Some agents (like morphine or meperidine) are used to relieve severe pain, while others (like acetaminophen) are administered to relieve less severe pain. The material in this section of the lesson will consider agents used to relieve less severe pain.

4-4. SPECIFIC ANALGESIC AGENTS

a. **Acetaminophen (Tylenol®).** Acetaminophen is used as an analgesic and as an antipyretic. It is not an anti-inflammatory agent: Acetaminophen will not relieve the swelling or redness found in arthritis or rheumatism. Side effects associated with this agent are itching or skin rash (most likely caused by hypersensitivity reactions), hemolytic anemia (persons with G-6-PD deficiency are especially susceptible), and kidney damage. This drug may cause liver damage with chronic use. Acetaminophen is available in capsule, elixir, suspension, syrup, tablet, chewable tablet, and suppository forms.

b. **Aspirin (A.S.A.).** Aspirin is used as an analgesic, anti-pyretic, and anti-inflammatory agent. Aspirin produces gastric irritation. Taking aspirin with a full glass of water or milk (8 fluid ounces) can help minimize stomach irritation. Tinnitus (ringing of the ears) is a symptom of aspirin overdose. Aspirin interacts with a variety of medications. One, the effects of oral hypoglycemic or insulin is increased when aspirin is administered concurrently with them. Two, since aspirin has some anti-coagulant effects, concurrent administration of aspirin, and some anti-coagulants can result in increased risk of patient bleeding. Patients should be cautioned against taking any oral aspirin preparation that has a strong vinegar-like odor. Aspirin is available in a variety of dosage forms (tablets, enteric coated tablets--dissolve in the intestines, and suppositories).

c. **Aspirin, Magnesium Hydroxide, and Aluminum Hydroxide Tablets (Cama®).** This aspirin-containing product is an analgesic, anti-inflammatory, and antipyretic agent. The magnesium hydroxide and aluminum hydroxide is in the formulation to reduce the stomach irritation associated with the aspirin. Patients taking this medication should be told not to take this medication with tetracyclines because the tetracycline's therapeutic effect might be decreased: This medication and tectracyclines should not be taken within one hour of each other. This product should be taken with at least 8 fluid ounces of water. Patients should be cautioned against taking this product if it has a strong vinegar-like odor.

d. **Propoxyphene Hydrochloride (Darvon®).** Propoxyphene is a centrally acting opioid analgesic. The drug may produce side effects such as dizziness, drowsiness, or blurred vision. Patients taking propoxyphene should be cautioned against taking alcohol or other central nervous system depressants while they are taking propoxyphene. Propoxyphene is a Note Q controlled substance.

e. **Propoxyphene Napsylate (Darvon N®).** Propoxyphene napsylate is used as an analgesic. It may produce such side effects as drowsiness and dizziness. Patients should be warned against taking alcohol or other central nervous system depressants when they are taking this drug. Darvon N® is a Note Q controlled substance.

f. **Pentazocine (Talwin®).** Pentazocine is a centrally acting opioid analgesic. Side effects associated with this agent are gastrointestinal upset, sedation, blurred vision, hallucinations, mental confusion, and shortness of breath. This medication should be used with caution in-patients who have a history of drug abuse or dependence. The oral dosage form (Talwin NX®) is combined with naloxone, a narcotic antagonist, to discourage the abuse of this substance. When the tablet is dissolved and then injected, the naloxone negates the euphoric effects of the pentazocine. Patients taking pentazocine should not take alcohol or any other central nervous system depressant at the same time, since this agent is a central nervous system depressant.

g. **Butalbital with Aspirin and Caffeine (Fiorinal®).** This product contains butalbital (a short-to-intermediate-acting barbiturate--50 mg), aspirin (325 mg), and caffeine (40 mg). The product is used as an analgesic. Side effects associated with this agent are gastrointestinal upset and sedation. This product may cause drug dependence. Patients taking this drug should not take any alcohol or any other central nervous system depressant. Fiorinal® is a Note Q controlled substance. (**NOTE:** Fiorinal® with Codeine is another formulation of this product. It is used to raise the threshold of pain.)

Section III. ANTI-INFLAMMATORY AGENTS

4-5. BACKGROUND

In certain conditions (that is, arthritis) or injuries, affected tissues become inflamed. The net effect of such inflammation is to surround the affected area and "wall it off" so that the movement of toxic products or bacteria from the affected part is delayed. Blood flow to the area is increased and certain changes happen in the capillaries to increase the fluid level of the tissues. Hence, the area becomes swollen. Redness of the area follows. Although this is a protective mechanism for the body, it is desirable at times to use drugs to decrease this effect.

4-6. SPECIFIC ANTI-INFLAMMATORY AGENTS

a. **Indomethacin (Indocin®).** Indomethacin is used in the treatment of various medical problems, including certain types of arthritis. Indomethacin is used to relieve swelling, inflammation, joint pain, stiffness, and fever. Patients hypersensitive to aspirin may also be hypersensitive to indomethacin. Side effects associated with the agent are gastrointestinal upset, headache, dizziness, and ringing or buzzing in the ears. Patients should be instructed to take this medication with food or milk or right after meals in order to lessen the possibility of gastrointestinal upset. Furthermore, in order to lessen gastrointestinal upset, patients should be instructed not to regularly drink alcoholic beverages or take aspirin unless their physician has told them otherwise. Since the drug does have the side effect of dizziness, the patient should be told not to drive or operate hazardous machinery until he or she has been taking the drug and has determined its effects on alertness.

b. **Ibuprofen (Motrin®).** Ibuprofen is used to treat the symptoms of arthritis. Ibuprofen relieves swelling, joint pain, stiffness, and inflammation. Some patients may have to take the drug for one to two weeks before they begin to feel its full effects. Side effects associated with the use of this agent include skin rashes, itching of skin, ringing or buzzing in the ears, dizziness, or a bloated feeling. Since the drug can cause some stomach irritation, the patient should not take alcohol or aspirin regularly while taking this drug unless the patient's physician has directed otherwise. Furthermore, since the drug does cause dizziness in some patients, the patient should be instructed not to drive or operate hazardous machinery until he or she has been taking the drug and has determined it affects on alertness.

c. **Tolmetin (Tolectin®).** Tolmetin is used to treat the symptoms of arthritis. The information for this drug is the same as for fenoprofen (Nalfon®)--see d above.

d. **Naproxen (Naprosyn®).** Naproxen is used to treat the symptoms of arthritis. Naproxen relieves swelling, joint pain, stiffness, and inflammation. Side effects associated with this agent include black tarry stools, blurred vision, skin rash, ringing or buzzing in the ears, and dizziness. Since this drug can cause some stomach irritation, the patient should not take alcohol or aspirin regularly while taking this drug unless the patient's physician directs otherwise. The drug may be taken with food, antacids, or milk to reduce stomach irritation.

e. **Sulindac (Clinoril®).** This drug is used to treat arthritis. This drug should be given with food twice daily; otherwise, the information for this drug is the same as is listed under naproxen (Naprosyn).

f. **Piroxicam (Feldene®).** This drug is a unique agent because it has a 45-hour half-life. This long half-life permits once daily dosing. Piroxicam is used in the treatment of rheumatoid arthritis, ankylosing spondylitis, and osteoarthritis. The average daily dose is 20 mg. Gastrointestinal side effects are encountered in approximately 20 percent of patients.

g. **Celecoxib (Celebrex®).** This drug is unique because it may cause less risk of gastrointestinal side effects than other anti-inflammatory agents. Celecoxib is used in the treatment of rheumatoid and osteo arthritis.

Section IV. ANTIGOUT AGENTS

4-7. BACKGROUND

a. Gout is a metabolic disease characterized by attacks of acute pain, tenderness, and swelling of such joints as the instep, ankle, great toe, and elbow. Gout is caused by the deposition of sodium urate micro crystals. This condition is seen primarily in males. It is thought that heredity plays a major factor in gout, because gout occurs more often in relatives of those who have gout than in the population in general.

b. Gout is caused by defective purine metabolism. Humans lack the enzyme uricase, an enzyme that converts uric acid to allantoin. Uric acid is a major end product of the metabolism of purine (indirectly of amino acid metabolism). The level of uric acid in the plasma and urine is normally high (saturated). Sometimes a moderate increase in uric acid production can lead to the deposition of sodium urate microcrystals as described above.

c. The treatment of gout is usually designed to (1) relieve pain and (2) increase the elimination of uric acid from the body. Drugs administered to increase the elimination of uric acid from the body are referred to as uricosuric agents.

4-8. DRUGS USED TO TREAT GOUT

a. **Colchicine.** While the exact mechanism of action of colchicine is unknown, the administration of the drug causes a decrease in the amount of urate crystals deposited in the various parts of the body--the result is a decrease in the inflammatory process. This drug is the oldest and most effective agent used in the treatment of acute attacks of gout. The usual dose of an acute gout attack is 1.2 milligrams immediately, then 0.6 milligram every 30 minutes to one hour until nausea and vomiting or diarrhea starts or pain is relieved. Each patient must initially titrate his own dosage. If seven tablets caused adverse effects the first administration, the patient should reduce the dosage to six tablets on the next acute attack. The usual side effect associated with the administration of colchicine is gastrointestinal irritation. Occasionally antidiarreheals are prescribed to offset this adverse effect. The patient should be informed to allow an interval of at least three days between treatments--otherwise, toxic effects may occur from accumulation.

b. **Allopurinol (Zyloprim®).** Allopurinol acts by decreasing the production of uric acid. This drug is not effective in the treatment of acute gout attacks, because it has no anti-inflammatory action. In fact, allopurinol may actually intensify the inflammation seen during an acute gout attack. Although the drug cannot be used to treat acute gout attacks, the patient should be instructed to continue taking allopurinol if he has such an attack. Allopurinol may produce such side effects as skin rash and gastrointestinal upset. If the drug causes too much gastrointestinal upset, the patient can take it after meals. The patient taking allopurinol should be instructed to drink at least 10 to 12 full glasses (8 fluid ounces per glass) of fluids each day--unless informed otherwise by his physician. This is done to prevent the formation of kidney stones while taking the drug.

c. **Probenecid (Benemid®).** Probenecid increases the urinary excretion of uric acid. This anti-gout agent has the following side effects associated with its use: bloody urine, lower back pain, and painful urination. The patient should be instructed not to drink too much alcohol while taking this drug since doing so could lessen the therapeutic effect of probenecid. Furthermore, the patient should be told not to take aspirin with this agent because salicylates antagonize the uricosuric action of probenecid.

Continue with Exercises

EXERCISES, LESSON 4

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson, and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Rheumatism is best described as:

   a. A form of arthritis that is caused by an excess of uric acid in the blood.

   b. A painful inflammation of body joints.

   c. A condition characterized by inflammation of connective tissue.

   d. A painful form of arthritis that causes gradual destruction of body joints.

2. Arthritis is best described as:

   a. A form of rheumatism in which the inflammation is limited to body joints.

   b. A destructive condition that attacks body joints by the accumulation of uric acid.

   c. A chronic condition characterized by the inability of the body's joints to become lubricated.

   d. An acute inflammation of the body joints and related connective tissue caused by infection or excess amounts of certain chemical substances in the body.

3. A patient complains that some aspirin she has at home is beginning to smell like vinegar. What should you tell her?

   a. Take the medication as usual -- nothing is wrong with it.

   b. Take the aspirin with at least 8 fluid ounces of water or milk.

   c. Never take more than two of those aspirin tablets at one time since the vinegar-like smell indicates the aspirin has increased in potency.

   d. Discard the aspirin and obtain a fresh supply.

4. A patient has been prescribed propoxyphene napsylate (Darvon N®). What should the patient be told?

   a. Take the medication with at least eight fluid ounces of water or milk.

   b. This medication should be taken at least one hour after taking tetracyclines.

   c. This medication should not be taken with alcohol or other CNS depressants.

   d. This medication should not be taken if it has a strong vinegar-like odor.

5. An elderly patient complains that he has been taking Motrin® for three days without experiencing much relief from his arthritis. What should the patient be told?

   a. Continue taking the drug since some patients have to take it for one or two weeks before they begin to feel its full effects.

   b. See the physician because the dosage probably needs to be increased.

   c. Stop taking the drug until pharmacy personnel ensure that the medication is not expired.

   d. Double the dose of the medication so the effects can be felt faster.

6. Gout is caused by:

   a. The defective metabolism of allantoin.

   b. The inflammation of connective tissue surrounding the body joints.

   c. Defective purine metabolism that causes sodium urate micro-crystals to be deposited in certain body joints.

   d. The incomplete elimination of uric acid from the body.

7. What should a patient who is taking Benemid® be told?

   a. This medication should not be taken with aspirin.

   b. This medication should not be taken with alcohol or other CNS depressants since Benemid® is a CNS depressant.

   c. This medication should not be taken on an empty stomach since it causes severe tissue irritation.

   d. This medication should be taken with antidiarrheals to lessen gastrointestinal irritation.

8. Select the use of pentazocine (Talwin®).

   a. Anti-gout agent.

   b. Anti-inflammatory agent.

   c. Antipyretic.

   d. Analgesic.

SPECIAL INSTRUCTIONS FOR EXERCISES 9 THROUGH 12. Match the drug name in Column A with its corresponding name in Column B.

COLUMN A	COLUMN B
9. _____ Benemid®	a. Ibuprofen
10 . _____ Motrin®	b. Butazolidin®
11. _____ Cama®	c. Aspirin, magnesium hydroxide, and aluminum hydroxide tablets
12. _____ Allopurinol	d. Probenecid
	e. Zyloprim®
	f. Colchicine

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 4

1. c (para 4-2d)
2. a (para 4-2e)
3. d (para 4-4b)
4. c (para 4-4d)
5. a (para 4-6b)
6. c (para 4-7a,b)
7. a (para 4-8d)
8. d (para 4-4f)
9. d Benemid®. (para 4-8d)
10. a Motrin®. (para 4-6b)
11. c Cama®. (para 4-4c)
12. e Allopurinol. (para 4-8c)

End of Lesson 4

LESSON ASSIGNMENT

LESSON 5	Review of Ocular and Auditory Anatomy and Physiology.
TEXT ASSIGNMENT	Paragraphs 5-1 through 5-13.
LESSON OBJECTIVES	5-1. Given the name of a part of the bulbus oculi and a group of statements, select the statement that best describes that part or its function.
	5-2. Given the name of one of the structures associated with the bulbus oculi (the adnexa) and a group of statements, select the statement which best describes that part or its function.
	5-3. Given the name of a disease/condition that affects the eye and a group of statements, select the statement that best describes that disease/condition.
	5-4. From a list of possible methods, select the method(s) by which sound may be transmitted.
	5-5. Given the name of one of the parts of the human ear and a group of statements, select the statement which best describes that part of the ear or its function.
	5-6. Given a disorder/malfunction of the ear and a group of statements, select the statement that best describes that disorder/ malfunction.
	5-7. Given a group of statements, select the statement that best describes how the body maintains equilibrium (balance).
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 5

REVIEW OF OCULAR AND AUDITORY ANATOMY AND PHYSIOLOGY

Section I. OCCULAR ANATOMY AND PHYSIOLOGY

5-1. BACKGROUND

a. **Stimulus.** Rays of light stimulate the receptor tissues of the eyeballs (bulbus oculi) to produce the special sense of vision. This includes both the sensation of vision or seeing and a variety of reactions known as the light reflexes. The actual reception of the light energy is a chemical reaction that in turn stimulates the neuron endings.

b. **Sense Organ**. The eyeball (bulbus oculi) is the special sense organ that contains the receptor tissues. The bulbus oculi is suspended in the orbit. The orbit is a skeletal socket of the skull that helps protect the bulbus oculi. Various structures associated with the functioning of the bulbus oculi are called the adnexa. The adnexa include the eyelids, the lacrimal system, and so forth.

5-2. THE BULBUS OCULI

See figure 5-1.

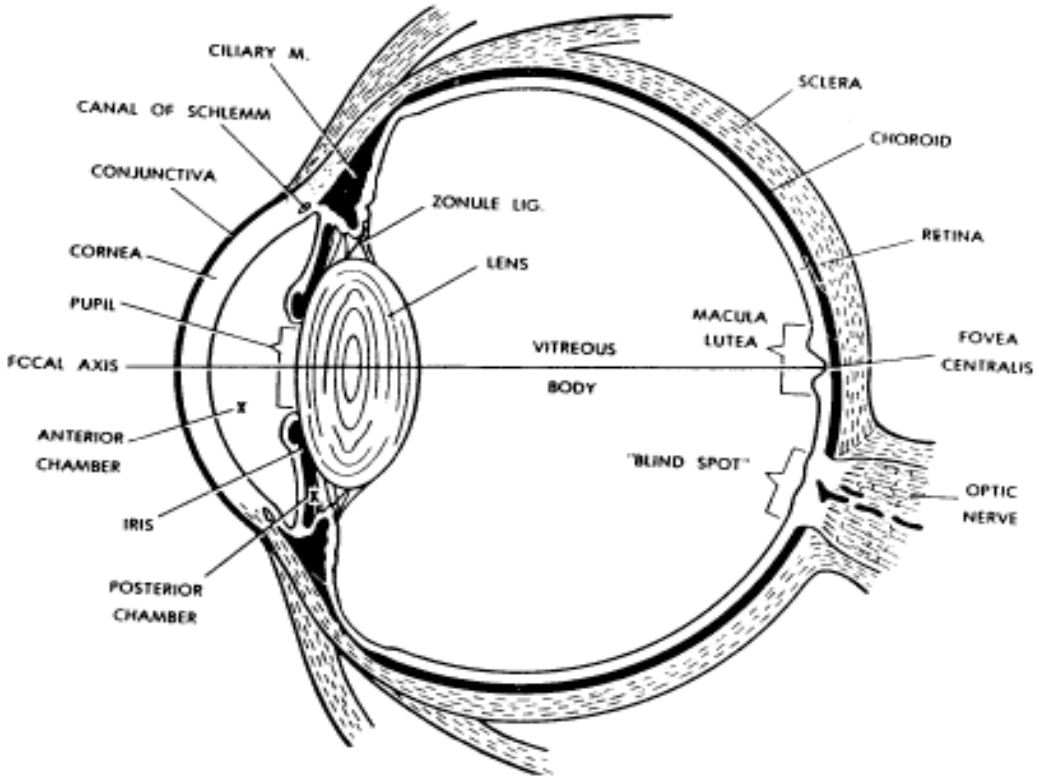

Figure 5-1. A focal-axis section of the bulbus oculi.

a. **Shape**. Normally the bulbus oculi is a spherical bulb-like structure. Its anterior surface, transparent and more curved, is known as the cornea of the bulbus oculi.

b. **Wall of the Bulbus Oculi**. The bulbus oculi is a hollow structure. Its wall is made up of three layers known as coats or tunics.

(1) Sclera. The outermost layer is white and very dense fibrous connective tissue (FCT). It is known as the sclera, scleral coat, or fibrous tunic. Its anterior portion is called the cornea. As already mentioned, the cornea is transparent and more curved than the rest of the sclera. The fixed curvature of the cornea enables it to serve as the major focusing device for the bulbus oculi.

(2) Choroid. The middle layer of the wall of the bulbus oculi is known as the choroid, the choroid coat, or the vascular tunic. This layer is richly supplied with blood vessels. It is also pigmented with a black material. The black color absorbs the light rays and prevents them from reflecting at random.

(3) Retina. The inner layer of the wall of the bulbus oculi is known as the retina, retinal coat, or internal tunic. The actual photoreceptor elements are located in the retina at the back and sides of the bulbus oculi. These elements are the rods and cones. They constitute the nervous portion of the retina. In the anterior part of the bulbus oculi, the retina continues as a non-nervous portion.

c. **Internal Structures of the Bulbus Oculi.**

(1) The nervous retina.

(a) The photoreceptors of the nervous portion of the retina (figure 5-2) contain chemicals known as visual pigments (rhodopsin). The cones are more concentrated in the center at the back of the bulbus oculi. The cones can perceive colors and are used for acute vision. However, cones require more intense light than do rods. The rods are distributed more toward the sides of the nervous retina. Although the rods are capable of perceiving less intense light, rods perceive only black and white.

(b) If you look directly at an object, light from the object will fall in the small depression of the retina called the fovea centralis. The fovea centralis is at the posterior end of the bulbus oculi, exactly opposite the centers of the cornea, pupil, and lens. The fovea centralis is found in a small yellow area of the retina called the macula lutea. The macula lutea is the area of the retina where vision is the sharpest.

FOVEA	=	small depression
CENTRALIS	=	center
MACULA	=	spot
LUTEA	=	yellow

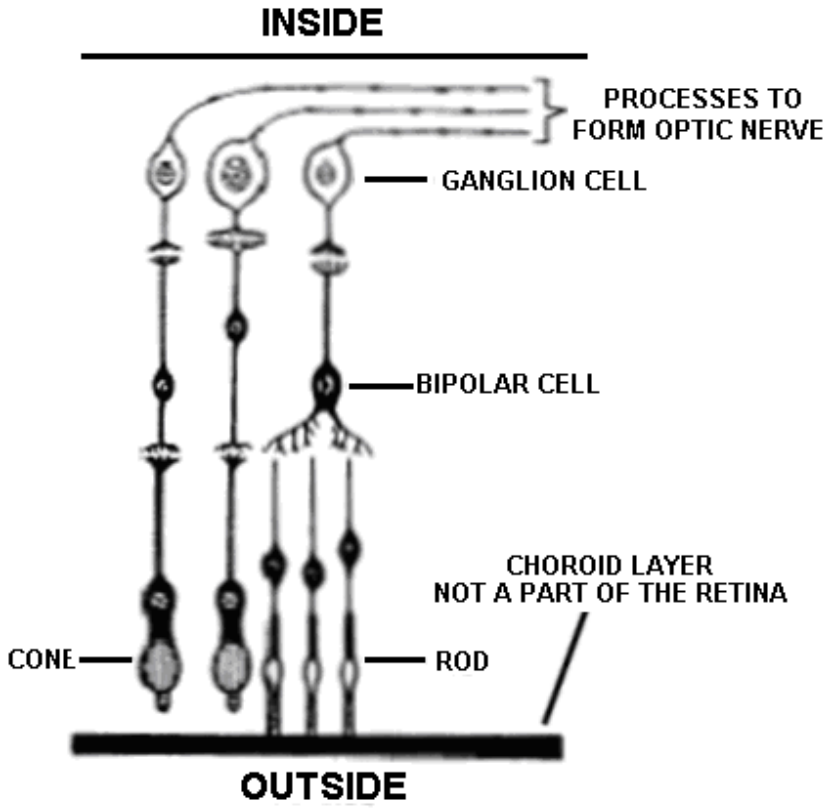

Figure 5-2. Cellular detail of retina.

(c) Associated with the rods and cones are the beginnings of neurons of the optic nerve. These neurons pass out of the bulbus oculi at the posterior end (in a point medial and superior to the fovea centralis). At the point of exit, there are not rods or cones. Therefore, it is called the blind spot (optic papilla/optic disk).

(2) Ciliary body. The anterior end of the choroid layer thickens to form a circular “picture frame” around the lens of the bulbus oculi. This is also near the margin of the base of the cornea. The frame-like structure is called the ciliary body. It includes mostly radial muscle fibers, which form the ciliary muscle.

(3) Ligaments. The lens is suspended in place by ligaments. These ligaments connect the margin (equator) of the lens with the ciliary body.

(4) Crystalline lens. The crystalline lens is located in the center of the anterior of the bulbus oculi, just behind the cornea.

(a) The lens is biconvex. This means that it has two outwardly curved surfaces. The anterior surface is flatter (less curved) than the posterior surface.

(b) The lens is transparent and elastic. As one grows older, the lens becomes less and less elastic. The ligaments maintain a tension upon the lens. This tension keeps the lens flatter and allows the lens to focus on distant objects. When the ciliary muscle contracts, the tension on the lens is decreased. The decreased tension allows the lens to thicken. The greater thickness increases the anterior curvature and allows close objects to be seen clearly.

(c) The process of focusing the crystalline lens for viewing close objects clearly is called accommodation. The process of accommodation is accompanied by a reduction in the pupil size as well as a convergence of the two central lines of sight (axes on bulbi oculi).

(5) Iris. Another structure formed from the anterior portion of the choroid layer is the iris. The iris is located between the lens and the cornea.

(a) The pupil is the hole in the middle of the iris. Radial and circular muscles in the iris control the size of the pupil. The radial muscles are dilators. The circular muscles are the constrictors. By changing the size of the pupil, the iris controls the amount of light entering the bulbus oculi.

(b) The iris may have many different colors. Multiple genes determine the actual color.

(6) Chambers. The space between the cornea and the lens is called the anterior cavity. The space between the cornea and the iris is referred to as the anterior chamber. The space between the iris and the lens is called the posterior chamber (see figure 5-1). Both chambers of the anterior cavity are filled with a fluid called the aqueous humor. The aqueous humor is secreted into the chambers by the ciliary body. It drains into the encircling canal of Schlemm, located in the angle between the cornea and the iris. This angle is called the irioiocornealis angle.

(7) Vitreous body. Behind the lens is a jelly-like material called the vitreous body. It fills the posterior cavity of the bulbus oculi.

5-3. THE ADNEXA

The adnexa are the various structures associated with the bulbus oculi.

a. **Extrinsic Ocular Muscles**. Among the adnexa are the extrinsic ocular muscles that move the bulbus oculi within the orbit (the cavity in the upper facial skull that contains the bulbus oculi).

b. **Eyelids.** Attached to the margins of the orbit, in front of the bulbus oculi, are the upper and lower eyelids. These have muscles for opening and closing the eyelids. The eyelashes (cilia) are special hairs of the eyelids that help protect these bulbus oculi. The margins of the eyelids have special oil to prevent the loss of fluids from the area. The inner lining of the eyelids is continuous with the conjunctiva, a membrane over the anterior surface of the bulbus oculi.

c. **Lacrimal Apparatus**. The conjunctiva must be kept moist and clean at all times. To do this, a lacrimal apparatus is associated with the eyelids. In the upper outer corner of the orbit is a lacrimal gland, which secretes a lacrimal fluid (tears) into the junction between the upper eyelid and the conjunctiva. The motion of the bulbus oculi and the eyelids (blinking) moves this fluid moved across the surface of the conjunctiva to the medialinferior aspect. Here, the lacrimal fluid is collected and delivered into the nasal chamber by the nasal lacrimal duct.

d. **Eyebrow.** The eyebrow is a special group of hairs above the orbit. The eyebrow serves to keep rain and perspiration away from the bulbus oculi.

e. **Optic Nerve.** Neurons carry information from the photoreceptors of the nervous retina. They leave the bulbus oculi at the blind spot. At the optic nerve, or second cranial nerve, the neurons pass to the rear of the orbit. There, the optic nerve exits through the optic canal into the cranial cavity. Beneath the brain, the optic nerves from both sides join to form the optic chiasma, in which half of the neurons from each optic nerve cross to the opposite side. Rom the optic chiasma, the right and left optic tracts proceed to the brain proper.

5-4. DISEASES/CONDITIONS AFFECTING THE EYE

a. **Myopia (“Near-Sightedness”).** In myopia the image from distant objects are focused in front of the retina. Myopia is caused by a lens that is too strong. Although the ciliary muscle is completely relaxed, the light rays entering the eye are not properly bent to be focused on the retina. This type of lens condition can be corrected by the use of a concave lens. Figure 5-3a illustrates this condition and correction with a concave lens.

b. **Hypermetropia (Hyperopia)(”Far-Sightedness”).** In hypermetropia, the parallel light rays entering the eye are not bent sufficiently by the lens and the image is focused behind the retina. In hypermetropia, the bulbus oculi is too short or the lens system is too weak when the ciliary muscle is relaxed. A convex lens is used to correct this condition. Figure 5-3b illustrates this condition and its correction with a convex lens.

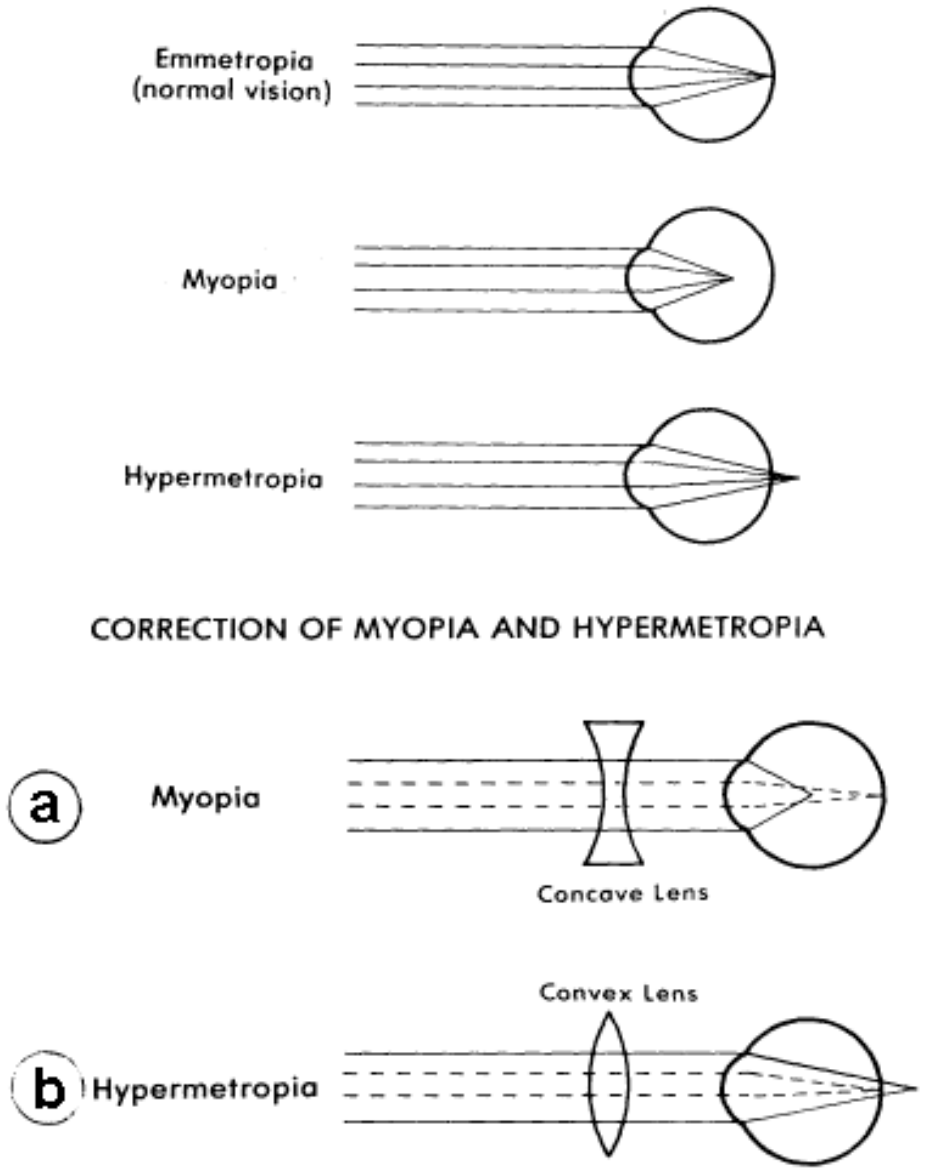

Figure 5-3. Myopia and hypermetropia contrasted with normal vision.

c. **Astigmatism.** Astigmatism occurs when the light rays passing through an astigmatic lens are not all focused at the same point. A malformed lens or cornea causes astigmatism. A specially designed lens can be used to help correct this condition.

d. **Glaucoma.** Glaucoma is a common cause of blindness. In glaucoma, the intraocular pressure becomes too great and causes damage to the retina and optic nerve. The intraocular pressure of a normal person is approximately 15 to 20 mm Hg (millimeters of mercury), while the intraocular pressure of a person with glaucoma can reach from 80 to 90 mm Hg. As the intraocular pressure increases, damage is done to the delicate tissues of the eye. The retinal artery, which enters the bulbus oculi at the optic disk, becomes increasingly compressed. Hence, nutrition to the retina is reduced and damage to the retina and optic nerve follow. Glaucoma can be either of a sudden onset or of a slow onset. Glaucoma results from the high pressure caused by reduced drainage of a fluid (aqueous humor). Because of the decreased drainage and continued fluid output, the high pressure develops. A variety of medications can be used to treat glaucoma. Pilocarpine, acetazolamide (Diamox®) and timolol (Timoptic®) are just three examples of such medications. These medications will be presented in later lessons.

e. **Cataracts.** A cataract is an irreversible and progressive clouding of the lens leading to blindness. Cataracts are surgically removed.

f. **Conjunctivitis.** Conjunctivitis is an inflammation of the conjunctiva.

Section II. AUDITORY ANATOMY AND PHYSIOLOGY

5-5. BACKGROUND

The human ear serves two major special sensory functions: hearing (auditory) and equilibrium (balance). The stimulus for hearing is sound waves. The stimulus for equilibrium is gravity.

a. **Methods of Sound Transmission**. The sound stimulus is transmitted in a variety of ways. Regardless of the actual transmission method, the sound stimulus is unchanged. Sound may be transmitted by:

(1) Airborne waves, which have frequency (pitch) and amplitude (loudness or intensity).

(2) Mechanical oscillations (vibrations) of structures.

(3) Fluid-born pressure pulses.

(4) Electrical impulses along the neurons to and in the brain.

b. **Sections of the Human Ear.** The human ear has three major parts (figure 5-4). Each part serves a specific function in the transmission and reception of the sound stimulus. The three parts are known as the external (outer) ear, the middle ear, and the internal (inner) ear.

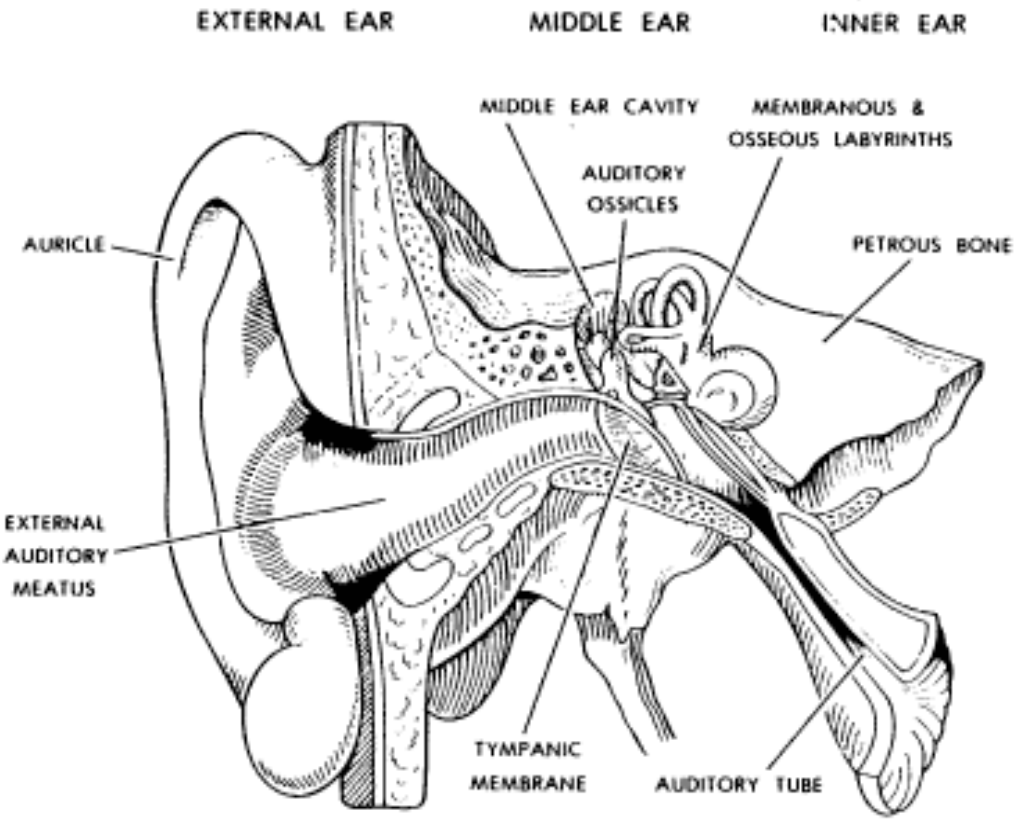

Figure 5-4. A frontal section of the human ear.

5-6. THE EXTERNAL EAR

The external ear begins on the outside of the head in the form of a funnel-shaped auricle (pinna). Actually serving as a funnel, the auricle directs airborne sound waves into the external auditory meatus. The external auditory meatus is a tubular canal extending into the temporal portion of the skull

5-7. THE MIDDLE EAR

a. **Tympanic Membrane.** At the inner end of the external auditory meatus is a tympanic membrane. The tympanic membrane (eardrum) is a circular membrane separating the external auditory meatus from the middle ear cavity. The tympanic membrane vibrates (mechanically oscillates) in response to airborne sound waves.

b**. Middle Ear Cavity**. On the medial side of the tympanic membrane is the middle ear cavity. The middle ear cavity is a space within the temporal bone.

c. **Auditory Ossicles**. The auditory ossicles (OSSICLE = small bone) are three very small bones which form a chain across the middle ear cavity. They join the tympanic membrane with the medial wall of the middle ear cavity. In order, the ossicles are named as follows: malleus, incus, and stapes. The malleus is attached to the tympanic membrane. A sound stimulus is transmitted from the tympanic membrane to the medial wall of the middle ear cavity by way of the ossicles. The ossicles vibrate (mechanically oscillate) in response to the sound stimulus.

d. **Auditory (Eustachian) Tube**. The auditory tube is a passage connecting the middle ear cavity with the nasopharynx. The auditory tube maintains equal air pressure on the two sides of the tympanic membrane.

e. **Association With Other Spaces**. The middle ear cavity is associated with other spaces in the skull. The thin roof of the middle ear cavity is the floor of part of the cranial cavity. The middle ear cavity is continuous posteriorly with the mastoid air cells via the antrum (an upper posterior recess of the middle ear cavity.

5-8. THE INTERNAL EAR

a. **Labyrinths.**

(1) Bony labyrinth. The bony labyrinth (LABYRINTH = a maze) is a complex cavity within the temporal bone. It has three semi-circular canals, a vestibule (hallway), and a snail-shaped cochlear portion.

(2) Membranous labyrinth. The membranous labyrinth is a hollow tubular structure suspended within the bony labyrinth.

b. **Fluids of the Internal Ear**. The endolymph is a fluid filling the space within the membranous labyrinth. The perilymph is a fluid filling the space between the membranous labyrinth and the bony labyrinth. These fluids are continuously formed and drained away.

ENDO = within
PERI = around

c. **The Cochlea**. The cochlea is a spiral structure associated with hearing. It has 2 1/2 turns. The snail- shaped portion of the bony labyrinth forms its outer boundaries.

(1) The central column or axis of the cochlea is called the modiolus. Extending from this central column is a spiral shelf of bone called the spiral lamina. A fibrous membrane called the basilar membrane (or basilar lamina) connects the spiral lamina with the outer bony wall of the cochlea. The basilar membrane forms the floor of the cochlear duct, the spiral portion of the mebranous labyrinth. Within the cochlear duct, there is a structure on the basilar membrane called the organ of Corti. The organ of Corti has hairs that are the sensory receptors for the special sense of hearing.

LAMINA = thin plate

(2) Within the bony cochlea, the space above the cochlear duct is known as the scala vestibuli and the space below is known as the scala tympani. Since the scala are joined at their apex, they form a continuous channel and the connection between them is called the helicotrema.

d. **Transmission.**

(1) The sound stimulus is transferred from the stapes to the perilymph of the scala vestibuli. Here the stimulus is transmitted as a pressure pulse in the fluid.

(2) In response, the basilar membrane of the cochlea vibrates (mechanically oscillates). Only selected portions of the basilar membrane vibrate at any one time, depending on the frequency of the sound stimulus.

(3) The hair cells of the organ of Corti at that particular location are mechanically stimulated. This stimulation is transferred to the neurons of the acoustic nerve. The acoustic nerve passes out of the modiolus into the cranial cavity and goes to the brain.

5-9. DISORDERS OR MALFUNCTIONS OF THE EAR

a. **Deafness.** Deafness can be divided into two types. One type is caused by the inability of the middle ear mechanisms to transmit sounds into the cochlea. This is sometimes called conduction deafness. Another type, usually referred to as nerve deafness, is caused by the impairment of the auditory nerve or cochlea. As one might expect, if either the cochlea or auditory nerve is destroyed, the patient is permanently deaf. However, if the cochlea and auditory nerve are still capable of functioning and only the ossicular system has been destroyed, the patient can still hear because sound waves can be conducted into the cochlea by bone conduction.

b. **Tinnitus.** Tinnitus is ringing in the ears or the sensation of noise in the ears or head. Persons who take large doses of certain drugs (like aspirin) complain of tinnitus.

c. **Meniere's Syndrome**. Meniere's Syndrome is a disorder characterized by intermittent attacks of vertigo (dizziness), nausea, vomiting, and profuse sweating. It is a disorder of the membranous labyrinth of the inner ear.

d. **Swimmer's Ear.** Swimmer's ear is a fungal infection of the outer ear.

e. **Otitis Media**. Otitis media is the inflammation of the middle ear or eardrum.

f. **Otitis Externa**. Otitis externa is the inflammation of the outer ear.

Section III. ANATOMY AND PHYSIOLOGY OF EQUILIBRIUM (BALANCE)

5-10. BACKGROUND

a. **Posture**. Posture is the specific alignment of the body parts at any given time. Humans can assume an infinite variety of postures. However, the truly erect posture is unique to humans.

b. **Equilibrium**. Equilibrium is the state of balance of the body. An erect standing human has a highly unstable equilibrium. Therefore, the human can easily fall. Through a variety of sensory inputs (visual, and so forth) and postural reflexes, the body is maintained in its erect posture.

c. **Stimulus-Gravitational Forces.** A primary sensory input for equilibrium consists of gravitational forces. This input is received by the membranous labyrinth within the internal ear. The gravitational forces are of two types: static, when the body is standing still, and kinetic, when the body is moving in either linear (straight) or angular directions.

d. **Membranous Labyrinth**. The specific portions of the membranous labyrinth involved are the two sac-like structures--the sacculus and the utriculus. Each of these two structures has an area of special hair cells called the macula. In addition, there are three semi-circular ducts located within the osseous semi-circular canals of the temporal bone of the skull. Each semi-circular duct has a crista, a little ridge of hair cells across the axis of the duct.

e. **"Body Sense."** All of the various sensory inputs related to the maintenance of equilibrium and posture are integrated within the brain as "body sense." Correct information is sent to the muscles of the body by means of specific postural reflexes in order to maintain the proper posture.

5-11. SACCULUS AND UTRICULUS

a. The sacculus and the utriculus are two sac-like portions of the membranous labyrinth. They are filled with endolymph.

b. On the wall of each sac is a collection of special hair cells known as the macula, which serves as a receptor organ for static and linear kinetic gravitational forces. The saccular macula and the utricular macula are oriented at more or less right angles to each other. For the pair of maculae in the membranous labyrinth of the right side, there is a corresponding pair in the labyrinth of the left side. Information from all of these maculae is sent into the brain for continuous sensing of the position of the head in space.

5-12. SEMICIRCULAR DUCTS

Extending from and opening into the utriculus are three hollow structures called the semicircular ducts. Since the utriculus completes the circle for each duct, the ducts act as if they were complete (figure 5-5).

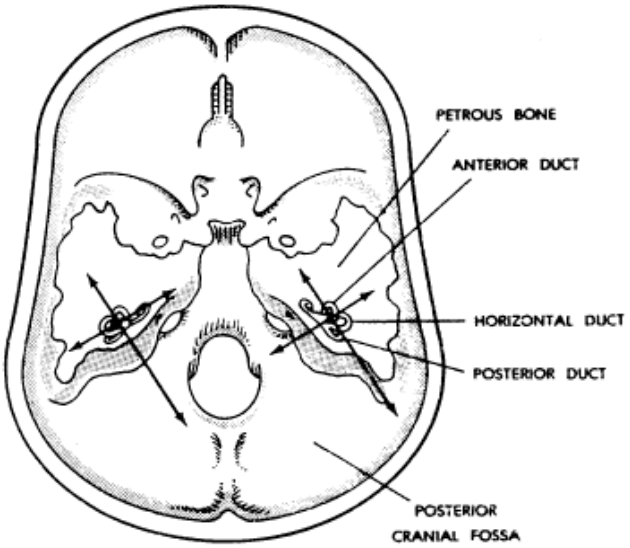

Figure 5-5. Diagram of semicircular duct orientation.

a. **Orientation**. Two of the ducts are vertically oriented (one anterior and one posterior). The third duct is essentially horizontal. The three ducts are all oriented at right angles to each other. In addition, the three ducts of one membranous labyrinth are matched or paired by the three ducts of the opposite membranous labyrinth.

b. **Ampullae and Cristae**. Each semi-circular duct ends with an enlargement where it opens into the utriculus. This enlargement or swelling is called an ampulla. The crista is at a right angle to the axis of the duct. Movement of the endolymph within the duct--caused by movement of the head in space--deforms (bends) the hairs of the crista in specific directions. These are responses to linear and/or angular kinetic gravitational forces.

5-13. THE VESTIBULAR NERVE

The vestibular nerve carries all this information from the maculae and cristae to the brain. The vestibular nerve is part of the auditory nerve. The auditory nerve (acoustic nerve) is a combination of the vestibular nerve (balance) and the otic nerve (hearing).

Continue with Exercises

EXERCISES, LESSON 5

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. The sclera is best described as:

   a. The inner layer of the wall of the bulbus oculi where the rods and cones of the eye are located.

   b. The white and very dense fibrous connective tissue that is the outermost layer of the bulbus oculi.

   c. The middle layer of the wall of the bulbus oculi.

   d. The transparent layer that forms the outermost portion of the bulbus oculi.

2. The retina is:

   a. The middle layer of the bulbus oculi that is pigmented black to absorb light rays so they will not be reflected at random within the eye.

   b. The transparent portion of the bulbus oculi that serves as the major focusing device for the eye.

   c. The inner layer of the wall of the bulbus oculi where the photo-receptor elements of the eye are located.

   d. The non-nervous portion of the inner layer of the bulbus oculi.

3. The cones of the bulbus oculi function to:

   a. Perceive black and white.

   b. Perceive colors.

   c. Prevent random reflection of light rays within the eye.

   d. Provide vision in conditions of little or no light.

4. What is the blind spot?

    a. The blind spot is a place in the cornea where there are no cones.

    b. The blind spot is a place in the retina where the optic nerve enters the bulbus oculi.

    c. The blind spot is an area located in the center of the anterior of the bulbus oculi.

    d. The blind spot is the origin of the optic nerve where there are no rods or cones.

5. The vitreous body is best described as:

    a. The space between the cornea and the lens.

    b. The jelly-like material that fills the posterior cavity of the bulbus oculi.

    c. The group of muscles responsible for controlling the size of the pupil.

    d. The colored portion of the anterior part of the choroid layer that is between the lens and the cornea.

6. The function of the lacrimal apparatus of the eye is to:

    a. Produce oil to prevent the loss of fluids from the bulbus oculi.

    b. Keep rain and perspiration away from the bulbus oculi.

    c. Open and close the eyelids.

    d. Keep the eye clean and moist at all times.

7. Myopia is best defined as:

    a. A condition in which the image from a distant object is focused in front of the retina.

    b. A condition in which the light rays entering the eye are focused behind the retina.

    c. A condition characterized by increased intraocular pressure which can result in blindness.

    d. A condition characterized by an irreversible and progressive clouding of the lens.

8. What is the function of the auditory (Eustachian) tube?

    a. This tube transmits from the tympanic membrane to the middle ear cavity.

    b. This tube carries sound waves from the external ear to the auditory ossicles.

    c. This tube maintains equal air pressure on the two sides of the tympanic membrane.

    d. This tube carries the sound waves from the external ear to the tympanic membrane.

9. The cochlea of the internal ear is best described as:

    a. A complex cavity within the temporal bone.

    b. A spiral structure associated with hearing.

    c. A hollow tubular structure suspended within the bony labyrinth.

    d. A structure containing fluid which is located between the membranous labyrinth and the bony labyrinth.

10. Meniere's Syndrome is best described as:

    a. An inflammation of the outer ear.

    b. An acute fungal infection of the outer ear.

    c. A disorder characterized by intermittent attacks of dizziness, nausea, vomiting, and profuse sweating.

    d. An inflammation of the middle ear or eardrum.

11. Conduction deafness is best described as:

    a. The type of deafness caused by the inability of the middle ear mechanisms to transmit sounds into the cochlea.

    b. The type of deafness caused by the impairment of the auditory nerve or cochlea.

    c. The type of deafness caused by the ossification of the tympanic membrane.

12. Which of the following statements best describes how the body maintains equilibrium?

    a. Information from the membranous labyrinth is sent to the brain.

    b. The semicircular ducts input energy to the brain.

    c. Movement of the endolymph within the semicircular duct provides all the equilibrium information to the brain.

    d. The brain receives sensory inputs from many sources and integrates this knowledge as "body sense."

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 5

1. b (para 5-2b(l))
2. c (para 5-2b)(3))
3. b (para 5-2c(1)(a))
4. d (para 5-2c(1)(c)
5. b (para 5-2c(7))
6. d (para 5-3c)
7. a (para 5-4a)
8. c (para 5-7d)
9. b (para 5-8c)
10. c (para 5-9c)
11. a (para 5-9a)
12. d (para 5-10e)

End of Lesson 5

LESSON ASSIGNMENT

LESSON 6 Review of the Autonomic Nervous System.

TEXT ASSIGNMENT Paragraphs 6-1 through 6-12.

LESSON OBJECTIVES

6-1. From a list, select the names of the two major divisions of the human nervous system.

6-2. From a list, select the names of the two divisions of the peripheral nervous system.

6-3. Given a group of statements, select the statement that best describes the autonomic nervous system.

6-4. Given a list, select the names of the two divisions of the autonomic nervous system.

6-5. Given a group of statements, select the statement that best describes the sympathetic nervous system.

6.6. Given a group of that best describes the statements, select the statement parasympathetic nervous system.

6-7. Given a group of statements, select the statement that best describes the physiology of the sympathetic nervous system.

6-8. Given a list of chemical substances, select the neurotransmitters of the sympathetic nervous system.

6-9. Given a group of statements and the name of one of the types of receptor sites of the sympathetic nervous system (alpha or beta), select the physiological effect produced by the stimulation of that receptor.

6-10. Given the name of a part of the body and a group of effects, select the effect produced on that part of the body by the sympathetic nervous system.

6-11. Given a group of statements, select the statement that best describes the physiology of the parasympathetic nervous system.

6-12. Given a list of chemical substances, select the chemical transmitter of the parasympathetic nervous system.

6-13. Given the name of a part of the body and a group of effects, select the effect produced on that part by the parasympathetic nervous system.

SUGGESTION

After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 6

REVIEW OF THE AUTONOMIC NERVOUS SYSTEM

Section I. INTRODUCTION

6-1. BACKGROUND

a. At some time in your life, you have faced a situation in which you have undergone a real scare. For example, have you ever been walking down a dark street at night and heard someone running toward you from behind? At that time, certain physiological changes took place in your body. Many of these changes directly involved the autonomic nervous system.

b. The autonomic nervous system (ANS) with its ability to make rapid internal adjustments is one of the most important systems present in the body in terms of the maintenance of body balance. The autonomic nervous system is very complex. Almost every organ of the body receives some type of effect produced by the autonomic nervous system.

c. Because of the wide distribution of the autonomic nervous system, many drugs produce definite effects upon it. This can occur as a blockade of natural activity or a direct effect mimicking natural stimulation. Many so-called side effects of drugs can also be traced to interference with normal autonomic function. Therefore, you must have an understanding of how the autonomic nervous system works and how various drugs can affect its operation. Many drugs used routinely and in emergencies are classified as autonomic nervous system drugs.

6-2. REVIEW OF THE HUMAN NERVOUS SYSTEM

a. The nervous system is divided into two major divisions--the central nervous system and the peripheral nervous system. As you will recall, the central nervous system is composed of the brain and spinal cord. The peripheral nervous system includes the parts of the nervous system other than the brain and spinal cord. Figure 6-1 illustrates the division of the human nervous system.

b. The peripheral nervous system has two divisions: the somatic nervous system and the autonomic nervous system. Figure 6-2 illustrates this division.

(1) Somatic nervous system. The somatic nervous system innervates skeletal muscle. It is under voluntary control and contains no ganglia. Acetylcholine is the chemical transmitter in the somatic nervous system (see lesson 2 of this subcourse).

(2) Autonomic nervous system. The autonomic nervous system is involuntary. It innervates smooth muscles, cardiac muscles, and gland cells. The autonomic nervous system aids the body in the fight or flight response.

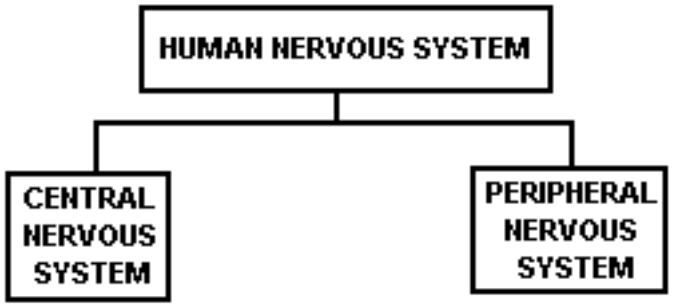

Figure 6-1. Divisions of the peripheral nervous system.

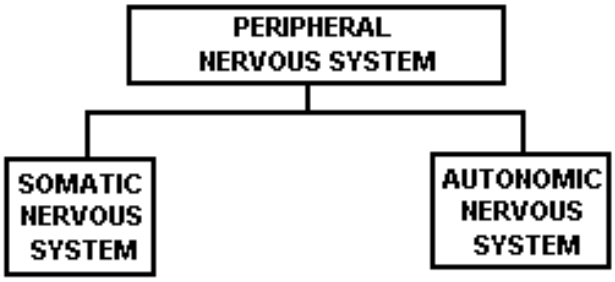

Figure 6-2. Divisions of the peripheral nervous system.

Section II. THE AUTONOMIC NERVOUS SYSTEM

6-3. INTRODUCTION

As was previously mentioned, the autonomic nervous system is one part of the peripheral nervous system. The autonomic nervous system is involuntary. It innervates smooth muscles, cardiac muscles, and gland cells. It aids the body in the fight or flight response. The autonomic nervous system helps to control urinary output, sweating, body temperature, arterial pressure, and gastrointestinal motility and secretion.

6-4. CONTROL OF THE AUTONOMIC NERVOUS SYSTEM

Centers located in the brain stem, hypothalamus, and spinal cord activate the autonomic nervous system.

6-5. ORGANIZATION OF THE AUTONOMIC NERVOUS SYSTEM

The autonomic nervous system is divided into two divisions: the sympathetic and the parasympathetic. Figure 6-3 illustrates this division.

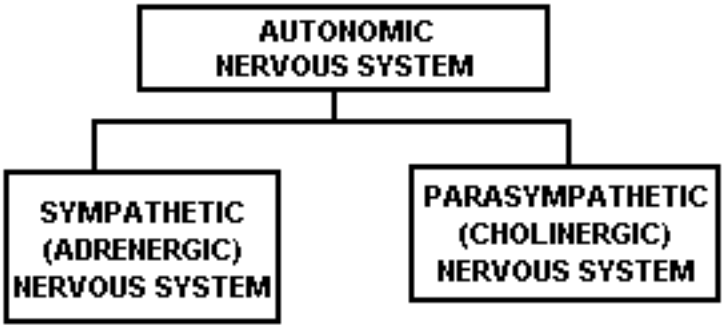

Figure 6-3. Divisions of the autonomic nervous system.

a. **Sympathetic Nervous System.** The sympathetic nervous system is frequently referred to as the adrenergic nervous system. Because of its transmitter epinephrine, which is more commonly known by its trade name "Adrenalin," it prepares the body for stress situations. Stimulation of the adrenergic nervous system has the general effect of expending energy. When a person is scared, this system prepares the body for the fight or flight response. In other words, it prepares the body to either fight or run. More information on this important system will be provided later in this lesson.

b. **Parasympathetic Nervous System.** The parasympathetic nervous system is usually referred to as the cholinergic nervous system. The cholinergic nervous system is responsible for bringing the body back to normal after the fight or flight response. The effects of the cholinergic nervous system are generally the opposite of those produced by the adrenergic nervous system. More information on the cholinergic nervous system will be provided later in this lesson.

Section III. THE SYMPATHETIC NERVOUS SYSTEM

6-6. INTRODUCTION TO THE SYMPATHETIC NERVOUS SYSTEM

You have already been told that the sympathetic nervous system is one component of the autonomic nervous system. Although this system is essential for a person in normal living, it is not crucial for a person to have this system if that individual is in a controlled environment (no stress, excitement, change in temperature, and so forth). Without the presence of this system, one's temperature would not adjust to the environmental temperature, one’s level of blood glucose would not increase during times of stress, and one’s resistance to fatigue would decrease.

6-7. PHYSIOLOGY OF THE SYMPATHETIC NERVOUS SYSTEM

a. The sympathetic nervous system (figure 6-4) is stimulated by the hypothalamus. The nerves of the sympathetic nervous system arise from the thoracolumbar section of the spinal cord. These nerves have short postganglionic fibers. These fibers synapse in the sympathetic chain ganglia that lie near the spinal cord. A ganglion is a joining of nerve fibers. Following synapse, the impulses travel down long postganglionic fibers and synapse at the effector organ.

b. The neurotransmitter at the preganglionic synapse is acetylcholine, while the neurotransmitters at the effector organ are norepinephrine and epinephrine. Norepinephrine and epinephrine are released by the adrenal medulla and circulate in the blood. Norepinephrine is also released by the postganglionic adrenergic neuron. The enzymes, catechol-o-methyltransferase (COMT) and monoamine oxidase (MAO) terminate transmission.

c. Circulating epinephrine and norepinephrine are destroyed by COMT. The norepinephrine, which is released by the neuron, is either reabsorbed by the neuron or destroyed in the synapse by MAO.

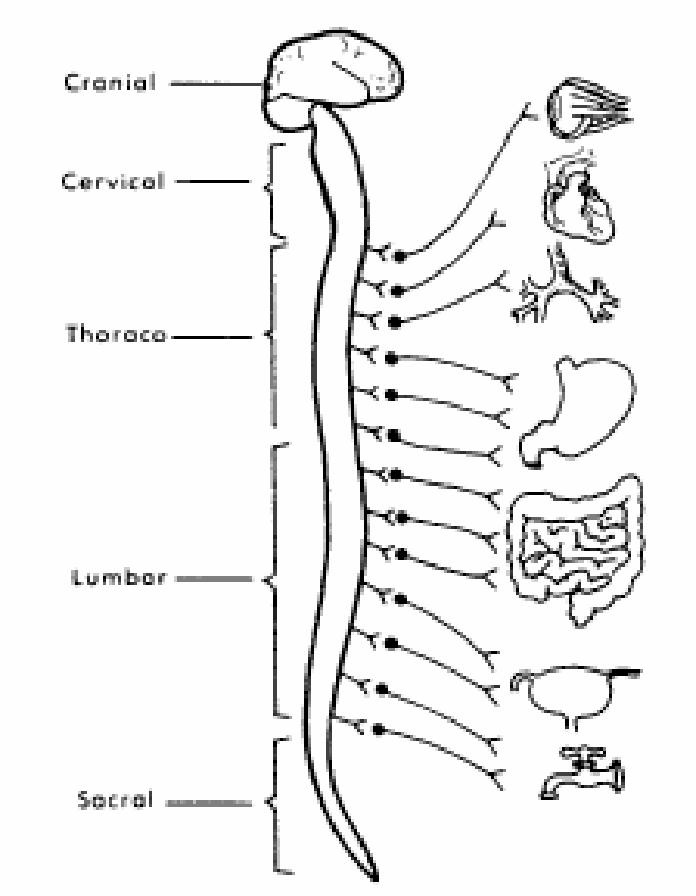

Figure 6-4. Sympathetic nervous system.

6-8. ALPHA AND BETA RECEPTOR SITES

It has been found that different effector organs have either alpha or beta predominant receptor sites.

a. **Alpha Receptors**. Alpha-receptors are associated mainly with increased contractibility of vascular smooth muscle and intestinal relaxation. Alpha-receptors have been classified into two types.

(1) $Alpha_1$. $Alpha_1$ receptors are located at the postsynaptic effector sites to stimulate transmitter release in smooth muscle (that is, contracts smooth muscle of peripheral blood vessels.

(2) $Alpha_2$. $Alpha_2$ receptors are located presynaptic on axon terminals to inhibit release of transmitter (norepinephrine). These predominate in the intestinal tract to cause relaxation.

b. **Beta Receptors**. Beta-receptors are associated with vasodilation and relaxation of nonintestinal smooth muscle and cardiac stimulation. Beta-receptors are divided into two types (example: bronchial dilation).

(1) $Beta_1$. $Beta_1$ receptors cause cardiac stimulation and lipolysis.

(2) $Beta_2$. $Beta_2$ receptors cause bronchodilatation, relaxation of blood vessels (usually skeletal muscles), and muscle glycogenolysis.

6-9. EFFECTS PRODUCED BY THE SYMPATHETIC NERVOUS SYSTEM

The sympathetic nervous system produces a variety of physiological effects upon the body. Listed below are some of these effects/responses:

a. **Eye (Pupil).** Mydriasis (dilation) of the pupil is produced by alpha stimulation.

b. **Heart.** Both an increase in heart rate and an increase in the contraction strength of the heart are produced by beta stimulation.

c. **Bronchi.** Relaxation of the bronchial muscle is produced by $beta_2$ stimulation.

d. **Blood Vessels.**

(1) Blood vessels in skeletal muscle. Constriction or dilation is produced--over the usual concentration range of physiologically released and circulating epinephrine, the beta-receptor response (vasodilation) predominates in blood vessels of skeletal muscle and liver. The alpha-receptor response (vasoconstriction) is obtained in blood vessels of other abdominal organs.

(2) Blood vessels in the skin and mucous membranes. Constriction is produced by alpha stimulation.

e. **Salivary Glands**. Thick and viscous secretions are produced by alpha stimulation.

f. **Stomach.** The motility and tone of the stomach muscle is usually decreased (alpha$_2$ and beta$_2$ stimulation) and the stomach sphincters are contracted (alpha stimulation).

g. **Intestines**. The motility and tone of the intestinal muscles are decreased (alpha$_2$ and beta$_2$ stimulation) and secretions are inhibited.

h. **Urinary Bladder**. The wall of the bladder is usually relaxed (beta stimulation) and the sphincter of the bladder is contracted (alpha stimulation) by stimulation from the sympathetic nervous system.

Section IV. THE PARASYMPATHETIC NERVOUS SYSTEM

6-10. INTRODUCTION TO THE PARASYMPATHETIC NERVOUS SYSTEM

You have already been told that the parasympathetic nervous system is one component of the autonomic nervous system. The parasympathetic nervous system (also referred to as the cholinergic nervous system) is responsible for bringing the body back to normal after the fight or flight response. The effects of the cholinergic nervous system are generally the opposite of those produced by the sympathetic (adrenergic) nervous system. The parasympathetic nervous system is responsible for maintaining the daily functions performed within the body. This division of the autonomic nervous system serves to conserve energy--it is necessary for life. Without the presence of this nervous system, the absorption of necessary nutrients would be hindered, gastrointestinal motility would be decreased, gastrointestinal secretions would be increased, and the urinary bladder and rectum would fail to empty.

6-11. PHYSIOLOGY OF THE PARASYMPATHETIC NERVOUS SYSTEM

a. The parasympathetic nervous system is stimulated by the hypothalamus. It has long preganglionic fibers and short postganglionic fibers (Figure 6-5). The short postganglionic fibers are usually located within the effector organ.

b. The chemical transmitter at both the preganglionic synapse and at the effector organ is acetylcholine. As mentioned previously, acetycholine is also the transmitter at skeletal muscle for the somatic nervous system; however, the receptors for the two nervous systems are different. Transmission of impulses is terminated by the destruction of acetylcholine by the enzyme acetylcholinesterase. Acetyicholinesterase is frequently referred to as cholinesterase. The general effects of parasympathetic stimulation are conservation and restoration of energy.

c. The parasympathetic nervous system does not have alpha and beta receptor sites.

6-12. EFFECTS PRODUCED BY THE PARASYMPATHETIC NERVOUS SYSTEM

The parasympathetic physiological activity on the organs is generally the opposite of the sympathetic with a few exceptions. The effect of the parasympathetic nervous system effects on some areas of the body are listed below:

a. **Eye (Pupil).** Contraction of the pupil (miosis) is produced by parasympathetic stimulation.

b. **Heart.** The parasympathetic nervous system produces a decrease in heart rate and a slight decrease in the contraction strength of the heart.

c. **Bronch**i. The bronchi are contracted by parasympathetic stimulation.

d. **Salivary Glands**. Parasympathetic nervous system stimulation of the salivary glands leads to profuse, watery secretions.

e. **Stomach**. Parasympathetic stimulation of the stomach leads to increased motility and tone and relaxed (usually) sphincters.

f. **Intestines**. Increased intestinal motility and tone and stimulated secretion of intestinal fluids are products of parasympathetic stimulation.

g. **Urinary Bladder**. Parasympathetic stimulation causes contraction of the bladder wall and relaxation of the sphincter.

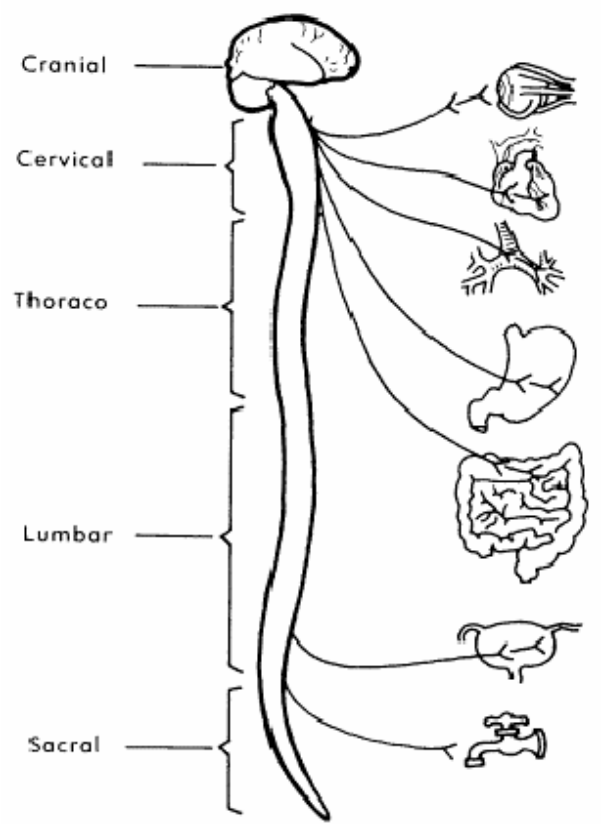

Figure 6-5. The parasympathetic nervous system.

Continue with Exercises

EXERCISES, LESSON 6

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. What are the two major divisions of the human nervous system?

   a. The central nervous system and the somatic nervous system.

   b. The central nervous system and the peripheral nervous system.

   c. The central nervous system and the autonomic nervous system.

   d. The central nervous system and the parasympathetic nervous system.

2. What are the two divisions of the peripheral nervous system?

   a. The central nervous system and the somatic nervous system.

   b. The autonomic nervous system and the parasympathetic nervous system.

   c. The somatic nervous system and the autonomic nervous system.

3. The autonomic nervous system is best described as:

   a. The part of the peripheral nervous system that is under voluntary control.

   b. The part of the peripheral nervous system that innervates skeletal muscle and which has acetylcholine as the chemical transmitter.

   c. The part of the peripheral nervous system that is involuntary and innervates smooth muscles, cardiac muscles, and gland cells.

   d. The part of the peripheral nervous system that is involuntary and is frequently referred to as the adrenergic nervous system.

4. Which of the following statements best describes the sympathetic nervous system?

    a. The component of the autonomic nervous system that has acetylcholine as its primary transmitter.

    b. The component of the autonomic nervous system that has epinephrine as its chemical transmitter.

    c. The component of the autonomic nervous system which is responsible for bringing the body back to normal after the fight or flight response.

    d. The component of the autonomic nervous system which is not crucial for a person to have if they live in a controlled environment (no stress).

5. The parasympathetic nervous system is best described as the component of the autonomic nervous system which:

    a. Has acetylcholinesterase as its chemical transmitter.

    b. Has epinephrine as its chemical transmitter.

    c. Is not crucial for a person to have if he/she lives in a controlled environment (no stress).

    d. Is responsible for bringing the body back to normal after the fight or flight response.

6. The neurotransmitter of the sympathetic nervous system at the preganglionic synapse is _____ while the neurotransmitters at the effector organ are _____ and _____.

    a. Epinephrine, norepinephrine, and acetylcholine.

    b. Acetylcholine, norepinephrine, and epinephrine.

    c. Epinephrine, acetylcholine, and acetylcholinesterase.

    d. Acetylcholine,catechol-o-methyltransferase, and monoamine oxidase.

7. Stimulation of beta-receptor sites results in:

    a. Vasodilation and relaxation of nonintestinal smooth muscle and cardiac stimulation.

    b. Increased contractility of vascular smooth muscle and intestinal relaxation.

    c. Contraction of smooth muscle.

    d. Vasocontraction of vascular smooth muscle.

8. Select the effect produced on the eye by the sympathetic nervous system.

    a. Mydriasis (dilation) of the pupil.

    b. Miosis (contraction) of the pupil.

9. Select the effect produced on the eye by parasympathetic stimulation.

    a. Mydriasis (dilation) of the pupil.

    b. Miosis (contraction) of the pupil.

10. Parasympathetic stimulation of the salivary glands leads to:

    a. Profuse, watery secretions.

    b. Thick and viscous secretions.

    c. None of the above.

11. Sympathetic stimulation of the intestines results in:

    a. Decreased motility and tone of the muscles.

    b. Increased motility and tone of the muscles.

    c. None of the above.

12. The chemical transmitter of the parasympathetic nervous system is:

    a. Epinephrine.

    b. Norepinephrine.

    c. Acetylcholinesterase.

    d. Acetylcholine.

13. Parasympathetic stimulation of the heart results in: (more than one response can be correct)

    a. Increased heart rate.

    b. Decreased heart rate.

    c. Increased contraction strength.

    d. Decreased contraction strength.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 6

1. b (para 6-2a)
2. c (para 6-2b)
3. c (para 6-2b(2))
4. b (para 6-5a)
5. d (para 6-5b)
6. b (para 6-7b)
7. a (para 6-8b)
8. a (para 6-9a)
9. b (para 6-12a)
10. a (para 6-12d)
11. a (para 6-9g)
12. d (para 6-llb)
13. b (para 6-12b)
    d (para 6-12b)

End of Lesson 6

LESSON ASSIGNMENT

LESSON 7 Adrenergic Agents.

TEXT ASSIGNMENT Paragraphs 7-1 through 7-6.

LESSON OBJECTIVES

7-1. Given a group of statements, select the mechanism(s) of action of drugs which stimulate the sympathetic nervous system.

7-2. Given the name of one of the receptor sites of the adrenergic nervous system and a list of effects, select the effect produced by the stimulation of that receptor site.

7-3. Given the name of a certain part of the body and a group of effects, select the effect produced on that part of the body by adrenergic stimulation.

7-4. Given a group of statements, select the best definition of the term adrenergic (sympathomimetic) drug.

7-5. Given the trade and/or generic name of an adrenergic (sympathomimetic) drug and a list of pharmacological effects, indications for use, cautions and warnings, or side effects, select the effect(s), use(s), caution(s) and warning(s), or side effect(s) for that drug.

7-6. Given the trade or generic name of an adrenergic (sympathomimetic) drug and a group of trade and/or generic names of drugs, select the appropriate trade or generic name for that drug.

SUGGESTION After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 7

ADRENERGIC AGENTS

7-1. BACKGROUND

The autonomic nervous system was discussed in lesson 6 of this subcourse. In that lesson, you learned of the sympathetic division of this nervous system. Specifically, it was stated that the sympathetic nervous system is frequently referred to as the adrenergic nervous system because of its transmitter epinephrine that is more commonly known by its trade name, "Adrenalin." The adrenergic nervous system prepares the body for stress situations. Stimulation of the adrenergic nervous system has the general effect of expending energy. When a person is scared, this system prepares the body for the fight or flight response.

7-2. MECHANISMS OF ACTION OF AGENTS WHICH STIMULATE SYMPATHETIC NERVOUS SYSTEM

Drugs that stimulate the sympathetic nervous system have a variety of mechanisms of action. These include:

a. Mimicking the action of the transmitter norepinephrine (see figure 7-1 for a diagrammatic representation of the sympathetic nervous system).

b. Rapidly displacing the transmitter from its storage site to activate the receptor.

c. Blocking the uptake of the transmitter into storage sites.

d. Inhibiting enzymes that break down the transmitter.

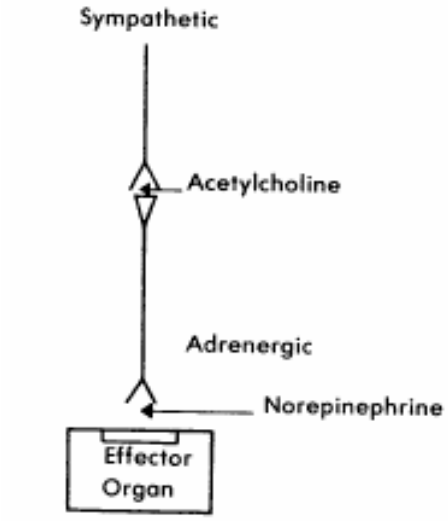

Figure 7-1. Diagrammatic representation of the sympathetic nervous system.

7-3. RECEPTOR SITE THEORY OF ADRENERGIC TRANSMISSION

Two types of receptor sites are theorized to explain adrenergic effects.

a. **Alpha-Receptors**. Alpha-receptors are associated mainly with increased contractibility of vascular smooth muscle and intestinal relaxation.

(1) Alpha$_1$. The alpha$_1$ is located at postsynaptic effector sites to stimulate transmitter release in smooth muscle. For example, the smooth muscle of peripheral blood vessels is contracted in alpha$_1$ stimulation.

(2) Alpha$_2$. The alpha$_2$ receptor site is located presynaptic on axon terminals to inhibit the release of norepinephrine (the transmitter). The effects of alpha$_2$ stimulation results in relaxation of the intestinal tract--motility and tone are decreased.

b. **Beta-Receptors**. Beta-receptors are associated with vasodilation and relaxation of nonintestinal smooth muscle and cardiac stimulation.

(1) Beta$_1$. Stimulation of beta$_1$ receptor sites results in cardiac stimulation and lipolysis.

(2) Beta$_2$. Stimulation of beta$_2$ receptor sites causes bronchodilation, relaxation of blood vessels (usually in skeletal muscles), and muscle glycogenolysis.

7-4. PHARMACOLOGICAL EFFECTS PRODUCED BY ADRENERGIC STIMULATION

a. **Certain Types of Smooth Muscle**. The adrenergic effect on certain types of smooth muscle--especially the blood vessels of the skin, mucous membranes, and salivary glands--is constriction. This is an alpha$_1$ effect.

b. **Other Types of Smooth Muscle**. The adrenergic effect on other types of smooth muscle varies according to the receptor site. The wall of the gut is relaxed through inhibition--this is an alpha$_2$ effect. The bronchial smooth muscle is dilated--this is a beta$_2$ effect. The blood vessels supplying skeletal muscle are dilated--this is a beta$_2$ effect.

c. **Cardiac Stimulation**. Cardiac stimulation is a beta$_1$ effect. Such stimulation results in increased heart rate and increased force of contraction by the heart.

d. **Metabolic Effects**. Beta$_2$ stimulation causes glycogenolysis in liver and muscle tissue. Beta$_1$ stimulation causes liberation of free fatty acids (lipolysis) from adipose tissue.

e. **Central Nervous System (CNS) Excitatory Actions**. Adrenergic stimulation results in respiratory stimulation, an increase in wakefulness, and in a reduction of appetite.

7-5. ADRENERGIC (SYMPATHOHIMETIC) DRUGS

Sympathomimetic drugs are agents which, when administered, will mimic (produce the same effects) normal adrenergic (sympathetic) stimulation. This normal adrenergic stimulation refers to the effects produced by epinephrine on the body. Two agents produce the adrenergic effects: epinephrine and norepinephrine. Epinephrine is the original model of the sympathomimetic agent. It has both Alpha and Beta activity. Figure 7-2 shows the chemical structure of epinephrine.

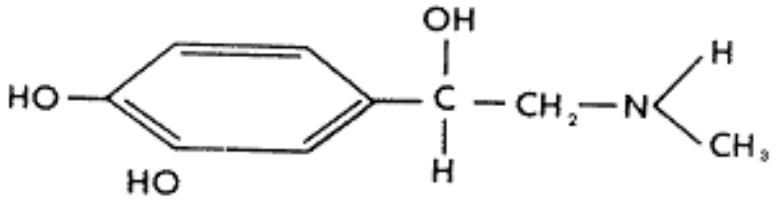

Figure 7-2. Chemical structure of epinephrine.

7-6. SPECIFIC ADRENERGIC (SYMPATHOMIMETIC) AGENTS

a. **Epinephrine (Adrenalin®).**

(1) Pharmacological effects.

(a) Blood pressure. The blood pressure in the skin and mucosa is increased via vasopressor action of peripheral vessels.

(b) Vascular effects. Epinephrine constricts the blood vessels of mucosa and the skin ($alpha_1$ effect). Physiological doses (0.5-1.0 milligram) administered subcutaneously) causes dilatation of vessels in skeletal muscle tissue. This effect decreases peripheral resistance and overcomes the vasoconstriction of peripheral vessels so that blood pressure is not greatly affected (predominantly beta effect). Large doses of epinephrine increase blood pressure: Alpha-receptor stimulation in the skeletal muscles overcome beta stimulation and the blood pressure is increased.

(c) Cardiac effects. Epinephrine acts upon $Beta_1$ receptors to greatly increase heart rate and output.

(d) Smooth muscle. The effect upon smooth muscle by epinephrine varies according to the organ stimulated and the type of adrenergic receptor effected in the muscle.

(e) Gastrointestinal (G.I.) tract. Epinephrine decreases the motility and tone of the gastrointestinal tract (alpha$_2$ and beta$_2$ effects).

(f) Central nervous system (CNS). Epinephrine provides some stimulation; therefore, it may produce some restlessness, apprehension, headache, and tremor.

(2) Indications for the use of epinephrine.

(a) Relieve bronchospasm. Epinephrine is used to relieve bronchiospasm as is seen with patients who have asthma. It opens the breathing pathways and allows for easier breathing.

(b) Prolong the action of local anesthetics. Epinephrine is sometimes combined with a local anesthetic (that is, lidocaine). Because epinephrine is a vasoconstrictor, it prolongs the effects of the local anesthetic by increasing the time the local anesthetic is in contact with the affected tissue (reduces blood flow to and from the area).

(c) Restore cardiac rhythm in cardiac arrest. Because of its effects upon the heart, epinephrine is administered to increase cardiac output and rate in persons who experience cardiac arrest.

(d) Stop bleeding on topical surfaces. Because it is a vasoconstrictor, epinephrine is sometimes applied to topical surfaces to reduce or stop bleeding.

(e) Treat allergic reactions. Epinephrine is the drug of choice for the treatment of anaphylactic shock. It overcomes the physiological effects of histamine (substance which causes the anaphylactoid reaction). It should be noted that epinephrine is not an antihistamine. One, epinephrine reverses the drop in blood pressure caused by the vasodilatation effect of histamine because epinephrine produces vasoconstriction. Two, the epinephrine reverses the bronchoconstriction produced by the anaphylaxis.

(3) Cautions and warnings associated with the use of epinephrine.

(a) Epinephrine can cause anxiety, tenseness, headache, and an awareness of a forceful, rapid heart beat.

(b) Epinephrine should be used cautiously in-patients who have hypertension (high blood pressure), hyperthyroidism, and heart disease (that is, angina).

b. **Norepinephrine, Levarterenol (Levophed®).** This adrenergic drug acts almost exclusively on alpha-receptors.

(1) Pharmacological effects.

(a) Peripheral vasoconstriction. Norephinephrine causes marked peripheral vasoconstriction.

(b) Constriction of blood vessels in skeletal muscles. Unlike epinephrine, norepinephrine produces constriction of blood vessels in skeletal muscles.

(c) Increase in blood pressure. Norepinephrine causes a net increase in blood pressure.

(2) Indication for the use of norepinephrine. Norepinephrine is used to restore blood pressure in selected hypotensive states (that is, when hypotension occurs during spinal anesthesia).

(3) Cautions and warnings associated with the use of norepinephrine.

(a) Norepinephrine can cause local necrosis due to vasoconstriction when it is injected intravenously. Therefore, it should be infused slowly into a rapidly flowing vein, and the site into which the drug solution is being administered should be changed every 12 hours.

(b) The drug can produce anxiety and transient headaches.

(c) Norepinephrine should be used cautiously with patients who have heart disease (that is, angina), hypertension, and hyperthyroidism.

c. **Isoproterenol (Isuprel®).** Isoproterenol produces a powerful action on both $beta_1$ and $beta_2$ receptors. It has no alpha activity. Injection or aerosol readily absorbs Isoproterenol; however, oral absorption of the drug is unreliable.

(1) Pharmacological effects.

(a) Cardiovascular effects. Isoproterenol produces increased cardiac output and decreased blood pressure. $Beta_2$ stimulation is responsible for the increase in heart rate and the increase in the force of contraction. Isoproterenol causes a reduction in blood pressure because of a decrease in peripheral resistance. $Beta_2$ receptors cause vasodilatation in skeletal muscle.

(b) Smooth muscle. Smooth muscle is relaxed by isoproterenol. This relaxation is most pronounced in the bronchi and gastrointestinal (G.I.) tract.

(c) Central nervous system (CNS). Isoproterenol produces some central nervous system stimulation.

(2) Indications for the use of isoproterenol. Isoproterenol is indicated in a variety of conditions. These include:

(a) Brochodilator in respiratory disorders.

(b) Cardiac stimulant in instances of heart block and cardiogenic shock following myocardial infarction or septicemia.

(3) Side effects associated with isoproterenol. Side effects associated with the use of isoproterenol include palpitation, tachycardia, headache, and flushing of the skin.

(4) Cautions and warnings associated with isoproterenol. Isoproterenol is contraindicated in-patients who have pre-existing cardiac arrhythmias associated with tachycardia.

d. **Dopamine (Intropin®).** Dopamine is a chemical compound in the body which is the immediate precursor (a substance from which another substance is formed) of norepinephrine.

(1) Pharmacological actions. Dopamine exerts both alpha and beta effects. When administered intravenously in doses of 1 to 10 micrograms per kilogram of body weight per minute, the drug acts primarily on beta and dopaminergic receptors. In higher doses, alpha-receptors are stimulated and the net effect of the drug is the result of alpha, beta, and dopaminergic stimulation. Dopaminergic receptors cause dilatation in renal and mesenteric vascular beds. $Beta_1$ effects result in an increase in cardiac output. Dopaminergic effects cause vasodilatation in mesenteric and renal beds.

(2) Indications for the use of dopamine. Dopamine is indicated in the treatment of shock syndrome, including cardiogenic shock, trauma, or hypovolemic shock.

(3) Cautions and warnings associated with the use of dopamine.

(a) Dopamine should not be used in the presence of uncorrected tachyarrhythmias or ventricular fibrillation.

(b) This drug should not be administered in the presence of hypovolemia (that is, to administer fluids).

(c) This drug should not be added to any alkaline dilution solution since the drug is inactivated in alkaline solutions.

e. **Metaproterenol (Alupent®).**

(1) Pharmacological actions. Because of its specificity for beta$_2$ receptors, metaproterenol causes a relaxation of the bronchi and uterus--little effect upon the heart is seen.

(2) Indication for the use of metaproterenol. Metaproterenol is used as a bronchodilator for bronchial asthma. It improves pulmonary function for a period of from 1 to 5 hours.

(3) Cautions and warnings associated with the use of metaproterenol:

(a) This drug is contraindicated with patients who have pre-existing cardiac arrhythmias associated with tachycardia.

(b) This drug is contraindicated in children under six years of age.

(4) Side effects associated with the use of this agent. Central nervous system (CNS) stimulation and muscle tremors are commonly seen in-patients who take this medication.

f. **Albuterol (Ventolin®).**

(1) Pharmacological actions. This drug is specific for beta$_2$ receptors and causes relaxation of the bronchi and uterus. It has a longer duration of action than metaproterenol

(2) Indications. Patients use albuterol as indicated for relief of broncho spasm with reversible obstructive airway disease and prevention of exercise-induced bronchospasm.

(3) Cautions and warnings.

(a) Safety and efficacy in children under age 12 have not been established.

(b) Use with caution in individuals with cardiovascular disorders.

(4) Side effects. Possible side effects associated with Albuterol include CNS stimulation and palpitations.

g. **Terbutaline (Brethine®, Bricanyl®).**

(1) Pharmacological actions. This drug is specific for $beta_2$ receptors with resultant relaxation of bronchial smooth muscle and uterus.

(2) Indication. Terbutaline is indicated as a bronchodilator for persons who have bronchial asthma. Terbutaline is longer acting than metaproterenol

(3) Cautions and warnings associated with terbutaline.

(a) This drug is contraindicated in patients who have preexisting cardiac arrhythmias associated with tachycardia.

(b) Terbutaline is not recommended for use with patients who are under 12 years of age.

(4) Side effects. Central nervous system (CNS) stimulation and muscle tremors are commonly seen in patients who take this drug.

h. **Amphetamine**.

(1) Pharmacological actions. Amphetamine is a powerful central nervous system (CNS) stimulant with both alpha and beta activity.

(a) CNS effects. Amphetamine causes the person to be awake and alert. Furthermore, the person feels a decreased sense of fatigue.

(b) Cardiovascular effects. Amphetamine increases cardiac input and increases blood pressure.

NOTE: Overdosing or repeated dosing can reverse the effects of amphetamine. This occurs because amphetamine promotes the release of norepinephrine from its storage sites. Thus, large amounts of amphetamine deplete the stores of norepinephrine and results in diminished or in no effect being produced (tachyphylaxis).

(2) Indications for the use of amphetamine derivatives. Amphetamine derivatives are used to treat a variety of conditions. They are as follows:

(a) Obesity. Amphetamine derivatives are sometimes prescribed to help an individual lose weight.

(b) Narcolepsy. Narcolepsy is a condition characterized by brief attacks of deep sleep. Amphetamine-like products are used to treat this condition because of its ability to stimulate the patient.

(c) Hyperkinetic syndrome (attention deficient disorder) in children. Amphetamine derivatives normally stimulate adults; however, in children, it produces a paradoxical (unexpected) effect of calming the patient, decreasing hyperactivity, and prolonging attention span.

NOTE: Amphetamine derivatives are Note R (Schedule II).

(3) Cautions and warnings.

(a) Patients taking amphetamine derivatives develop tolerance and psychological dependence with chronic use.

(b) Amphetamine derivatives should be used cautiously with patients who have arteriosclerosis, cardiovascular disease, glaucoma, hypertension, and hyperthyroid sin.

(4) Side effects. Side effects commonly seen in patients who take amphetamine like products are restlessness, tremor, hyperactive reflexes, irritability, insomnia, euphoria, and confusion.

i. **Ephedrine.**

(1) Pharmacological effects. Ephedrine directly stimulates both alpha and beta-receptors and indirectly stimulates Alpha-receptors by causing release of norepinephrine. Ephedrine is similar to epinephrine; however, it is longer acting and produces more effect on the central nervous system (CNS). Ephedrine produces cardiovascular effects similar to those produced by epinephrine. Finally, the bronchial muscle relaxation produced caused by ephedrine is less intense, but more sustained than that caused by epinephrine.

(2) Indications. Ephedrine is most commonly used as a bronchodilator. It is also used as a nasal decongestant, as a treatment for narcolepsy, and as agent to control blood pressure in patients under the effects of spinal and epidural anesthesia.

(3) Caution and warning. Ephedrine is contraindicated in patients who have severe hypertension and chronic heart disease.

j. **Metaraminol (Aramine®).**

(1) Pharmacological effects. Metaraminol produces alpha stimulation with $beta_1$ effects. The vasoconstriction produced by metaraminol is very pronounced. The $beta_1$ effects produced by metaraminol are similar to epinephrine. Overall, metaraminol produces less potent and longer duration with more gradual onset than the effects produced by norepinephrine.

(2) Indications. Metaraminol is indicated in the treatment of hypotensive states (that is, shock); however, it must be used with caution because it increases the myocardium's demand of oxygen.

(3) Cautions and warnings. Metaraminol may induce arrhythmias in large doses. Furthermore, the drug should be used with caution with patients who have heart disease, thyroid disease, hypertension, or diabetes.

k. **Phenylephrine (Neo-Synephrine®).**

(1) Pharmacological effects. Phenylephrine is a powerful alpha stimulator with little or no effect on beta-receptors.

(2) Indications. Phenylephrine has a variety of uses. These include:

(a) Nasal decongestant.

(b) Vasopressor. The drug is used as a vasopressor for hypotension associated with spinal anesthesia and neurogenic shock.

(c) Mydriatic. The drug is used to produce mydriasis (dilatation of the pupil).

(3) Cautions and warnings. The drug is contraindicated in hypertension and existing ventricular tachycardia. Phenylephrine can induce cardiac irregularities.

l. **Tetrahydrozoline (Tyzine®).**

(1) Indications. This drug is used as a nasal decongestant.

(2) Caution and warning. Prolonged use of this agent as a nasal decongestant may produce chemical rhinitis.

(3) Side effects. Tetrahydrozoline may cause sneezing, stinging or burning of the mucous membranes, insomnia, or tachycardia.

NOTE: Agents listed in m and n, below, are referred to as incomplete sympathomimetics. They produce topical vasoconstriction of the nasal mucosa or conjunctiva. They have no direct effect on the myocardium or on the smooth muscle of the bronchioles. However, they do relax the intestine. Remember, although both the intestine and the bronchi are smooth muscles, they are affected by different receptors. Intestinal relaxation is moderated by $alpha_2$ receptors and bronchi relaxation by $beta_2$ receptors.

m. **Xylometazoline (Otrivin®).**

(1) Indications. Xylometazoline is used as a nasal decongestant.

(2) Caution and warning. No significant caution and warning is associated with the drug.

(3) Side effects. Side effects associated with this drug include stinging or burning of the mucous membranes, dry nose, and rebound congestion.

n. **Oxymetazoline (Afrin®).**

(1) Indications. Oxymetazoline is used as a nasal decongestant.

(2) Caution and warning. No significant caution and warning is associated with the drug.

(3) Side effects. Side effects associated with oxymetazoline include rebound congestion, dryness of the nose, and stinging or burning of the mucous membranes.

Continue with Exercises

EXERCISES, LESSON 7

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete sentence.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson, and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Select the mechanism(s) of action of drugs that stimulate the sympathetic nervous system.

   a. Mimicking the action of the transmitter acetylcholine.

   b. Rapidly displacing the transmitter from its storage site to activate the receptor.

   c. Increasing the uptake of transmitter into the storage sites.

   d. Helping the enzymes that break down the transmitter.

2. Stimulation of the beta2 receptor site results in:

   a. Intestinal relaxation.

   b. Decreased motility of the intestinal tract.

   c. Bronchodilation.

   d. Cardiac stimulation.

3. What is the effect upon the heart of adrenergic stimulation?

   a. No effect is known.

   b. Decreased cardiac output.

   c. Increased heart rate.

   d. Decreased force of contraction.

4. The pharmacological effect of epinephrine (Adrenalin®) upon the gastrointestinal (G.I.) tract is:

   a. Increases motility and tone.

   b. Decreases motility and tone.

   c. Increases secretions.

   d. None of the above.

5. What is the indication for the use of norepinephrine?

   a. To prolong the action of local anesthetics.

   b. To stop bleeding on topical surfaces.

   c. To treat allergic reactions.

   d. To restore blood pressure in selective hypotensive states.

6. Isoproterenol (Isuprel®) is used in a variety of conditions. It is used:

   a. To restore blood pressure in selected hypotensive states.

   b. As a bronchodilator in respiratory disorders.

   c. To stop bleeding on topical surfaces.

   d. As a local vasoconstrictor to prolong the effects of local anesthetics.

7. Metaproterenol (Alupent®) is indicated for use as a:

   a. Bronchodilator for bronchial asthma.

   b. Nasal decongestant.

   c. Treatment for narcolepsy.

   d. Cardiac stimulant.

8. Ephedrine is most commonly used as a (n):

    a. Cardiac stimulant.

    b. Bronchodilator.

    c. Peripheral vasoconstrictor.

    d. Intestinal stimulant.

9. Caution should be used if patients that use metaraminol have:

    a. Diabetes.

    b. Thyroid disease.

    c. Hypertension.

    d. All the above.

10. Tetrahydrozoline (Tyzine®) is commonly used as a:

    a. Nasal decongestant.

    b. Cardiac stimulant.

    c. Mydriatic.

    d. Vasopressor.

11. One side effect associated with oxymetazoline (Afrin®) is:

    a. Rebound congestion

    b. Loss of appetite.

    c. Cardiac arrhythmias.

    d. Hypertension.

12. Match the trade or generic name in Column A with its appropriate trade or generic name in Column B.

	Column A	Column B
_____	Xylometazoline®	a. Otrivin®
_____	Levophed®	b. Metaraminol
_____	Intropin®	c. Metaproterenol
_____	Epinephrine	d. Dopamine
_____	Aramine®	e. Terbutaline
_____	Brethine®	f. Adrenalin
_____	Neo-Synephrine®	g. Phenylephrine
_____	Alupent®	h. Levarterenol

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 7

1. b (para 7-2b)

2. c (para 7-3b(2))

3. c (para 7-4c)

4. b (para 7-6a(1)(e))

5. d (para 7-6b(2))

6. b (para 7-6c(2)(a))

7. a (para 7-6e(2))

8. b (para 7-6i(2))

9. d (para 7-6j(3))

10. a (para 7-6l(1))

11. a (para 7-6n(3))

12. a Xylometazoline. (para 7-6m)
    h Levophed®. (para 7-6b)
    d Intropin®. (para 7-6d)
    f Epinephrine. (para 7-6a)
    b Aramine®. (para 7-6j)
    e Brethine®. (para 7-6g)
    g Neo-Synephrine®. (para 7-6k)
    c Alupent®. (para 7-6e)

End of Lesson 7

LESSON ASSIGNMENT

LESSON 8 Adrenergic Blocking Agents.

TEXT ASSIGNMENT Paragraphs 8-1 through 8-5.

LESSON OBJECTIVES

8-1. Given a group of statements, select the statement that best describes one of the mechanisms of actions of adrenergic blocking agents.

8-2. Given a category of drugs (alpha-blockers or beta-blockers) and a group of statements, select the statement that best describes the mechanism by which that category of drugs produces its effects.

8-3. Given the trade and/or generic name of an adrenergic blocking agent, classify that agent as either an alpha or beta blocker.

8-4. Given the trade and/or generic name of an adrenergic blocking agent and a group of pharmacological actions, indications/uses, and side effects, select the action(s), indication(s)/use(s), and side effect(s) associated with that agent.

8-5. Given the trade or generic name of an adrenergic blocking agent and a group of trade and generic names of drugs, select the appropriate trade or generic name for the stated drug.

SUGGESTION After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 8

ADRENERGIC BLOCKING AGENTS

8-1. INTRODUCTION TO ADRENERGIC BLOCKING AGENTS

a. In the last lesson, the topic of adrenergic (sympathomimetic) agents was discussed. As you will recall, this group of drugs produces effects like those produced by epinephrine.

b. This lesson will focus on the topic of adrenergic blocking agents. This group of agents blocks or interferes with the types of responses typically caused by the transmitters of the adrenergic (sympathetic) nervous system. Adrenergic blocking agents are sometimes referred to as sympatholytic agents.

8-2. GENERAL MECHANISMS OF ACTION OF ADRENERGIC BLOCKING AGENTS

There are two basic categories of mechanisms of action demonstrated by adrenergic blocking agents.

a. Some adrenergic blocking agents inhibit the synthesis, storage, or release of norepinephrine. Therefore, less norepinephrine is available to the receptors to produce its effects (adrenergic stimulation).

b. Other adrenergic blocking agents inhibit the reaction between norepinephrine and the receptor.

8-3. PRINCIPAL TYPES OF ADRENERGIC RECEPTORS

a. **Alpha-Receptors.** Alpha-receptors produce salivation, sweating, and contraction of smooth muscle (except in the gastrointestinal tract).

b. **Beta-Receptors**. Beta-receptors increase the frequency and strength of the heartbeat and cause relaxation of smooth muscle (except in the gastrointestinal tract).

8-4. ALPHA-ADRENERGIC BLOCKING AGENTS

Effects produced by these agents occur because the alpha-receptors are blocked while beta-receptors are still capable of producing their effects.

a. **Phentolamine (Regitine®).**

(1) Pharmacological actions.

(a) Phentolamine causes blockage of the $alpha_1$ receptors. This causes vasodilatation, resulting in decreased blood pressure.

(b) Phentolamine also causes blockage of $alpha_2$ receptors. This causes a release of norepinephrine. Since the normal effect of norepinephrine is blocked at the $alpha_2$ receptor, the effect of epinephrine on the cardiac beta-receptors occurs.

(2) Indication/use. Phentolamine is used to prevent or treat dermal necrosis and sloughing caused by the extravasation (administration outside the vein) of norepinephrine (levarterenol).

(3) Side effects. Phentolamine can cause side effects such as tachycardia, flushing, cardiac arrhythmias, and orthostatic hypotension.

b. **Prazosin (Minipress®).**

(1) Pharmacological actions. Prazosin is an antihypertensive agent that selectively blocks $alpha_1$ receptors. This drug produces vasodilation and reduces peripheral resistance, but it produces little effect upon cardiac output.

(2) Indications/uses. Prazosin is an antihypertensive agent.

(3) Cautions and warnings. This agent should be used caution with patients who have severe cardiac disease or a history of mental depression.

(4) Side effects. Side effects associated with the use of prazosin include dizziness, sudden fainting, drowsiness, and lack of energy.

c. **Other Alpha Blockers**. Other alpha blockers include Terazosin (Hytrin®) and Doxazosin (Cardura®). They are used for hypertension.

8-5. BETA-ADRENERGIC BLOCKING AGENTS

Beta-adrenergic blocking agents block beta effects--cardiac rate and force of contraction, vasodilatation in skeletal muscles, hyperglycemia, and bronchodilatation.

a. **Propranolol (Inderal®).**

(1) Pharmacological action. Propranolol blocks both $beta_1$ and $beta_2$ receptors.

(2) Indications/uses. Propranolol is used to treat a variety of conditions. Its uses are listed below:

(a) Antianginal agent. It lessens the heart's need for oxygen because it slows the heart rate. With a slower heart rate, there is decreased need for oxygen and the angina pain diminishes.

(b) Antiarrhythmic agent.

(c) Antihypertensive agent.

(d) Suppressant agent (in the treatment of migraine headaches)

(3) Cautions and warnings. Propranolol should not be administered to patients who have bronchial asthma, cardiogenic shock, or sinus bradycardia. It should be used in caution with patients who have a history of allergies, diabetes mellitus, congestive heart failure, and emphysema. It is important to note that the abrupt withdrawal of this agent with patients who have heart disease (that is, angina) can cause arrhythmias or myocardial infarction (heart attack). This occurs because the sympathetic tone is adjusted to the blockage (probably by producing extra amounts of norepinephrine); thus, when the blockage is withdrawn, the heart cannot tolerate the extra norepinephrine that is present.

(4) Side effects. Side effects that can be produced by propranolol include dizziness or lightheadedness, very slow pulse, mental confusion or depression, cold hands, and numbness of the toes or fingers.

b. **Metoprolol Tartrate (Lopressor®).**

(1) Pharmacological actions. Metoprolol is a somewhat selective beta1 blocker.

(2) Indication. Metoprolol is used as an antihypertensive agent.

(3) Side effects. Side effects associated with this agent include dizziness or drowsiness, mental depression, and hallucinations.

c. **Atenolol (Tenormin®).**

(1) Pharmacological actions. Atenolol is a selective beta1 blocker; its long half-life permits once daily dosing.

(2) Indications. Atenolol is used as an antihypertensive agent and for the treatment of angina pectoris because of coronary atherosclerosis.

(3) Side effects. Side effects include dizziness, drowsiness, and some mental depression, but less than that of other agents.

d. **Timolol (Timoptic®).**

(1) Pharmacological actions. Timolol has both beta1 and beta2 blocking activity.

(2) Indications. The oral tablets are used as an anti-hypertensive agent. The eye drops are used for glaucoma.

(3) Side effects. Possible side effects include dizziness, drowsiness, hallucinations, fatigue, slow pulse, confusion, depression, and cold hands and feet.

Continue with Exercises

EXERCISES, LESSON 8

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete sentence.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which of the following statements best describes one of the mechanisms of action of adrenergic blocking agents?

   a. The production of excessive levels of acetylcholinesterase.

   b. The inhibition of the reaction between norepinephrine and the receptor.

   c. The inhibition of the synthesis, storage, or release of acetylcholine.

   d. The production of substances that produce physiological effects the opposite of norepinephrine.

2. Which of the following statements describes how alpha-adrenergic blocking agents produce their effects?

   a. The alpha-receptors are blocked and this allows the parasympathetic nervous system to produce its effects.

   b. The alpha-receptors are blocked while the beta-receptors still produce their effects.

   c. The alpha-receptors as well as the beta1 receptors are blocked, but the beta2 receptors still produce their effects.

   d. The alpha-receptors are blocked and the effects of the beta-receptors are antagonized.

3. Prazosin is used as:

   a. An antianginal agent.

   b. A suppressant agent (in the treatment of migraine headaches).

   c. An antihypertensive agent.

   d. A vasodilator.

4. Side effect(s) commonly associated with phentolamine (Regitine®) include:

   a. Bradycardia.

   b. Cardiac arrhythmias.

   c. Sudden fainting.

   d. Extremely slow pulse rate.

5. What side effect is commonly associated with propranolol?

   a. Very slow pulse.

   b. Mental confusion.

   c. Dizziness.

   d. All the above.

6. Metoprolol tartrate is used as a(n):

   a. Antianginal agent.

   b. Antihypertensive.

   c. Means to prevent or treat dermal necrosis and sloughing caused by the extravasation of norepinephrine.

   d. Suppressant agent (in the treatment of migraine headaches).

7. The drug prazosin is classified as a(n):

    a. Alpha-blocker.

    b. Beta-blocker.

8. The trade name of prazosin is:

    a. Minipress®.

    b. Inderal®.

    c. Lopressor®.

    d. Prapressor®.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 8

1. b (para 8-2)
2. b (para 8-4)
3. c (para 8-4)
4. b (para 8-4a(3))
5. d (para 8-5a(4))
6. b (para 8-5b(2))
7. a (para 8-4b)
8. a (para 8-4b)

End of Lesson 8

LESSON ASSIGNMENT

LESSON 9 Cholinergic Agents.

TEXT ASSIGNMENT Paragraphs 9-1 through 9-6.

LESSON OBJECTIVES

9-1. Given a group of statements, select the statement that best describes the term cholinergic agent.

9-2. Given a group of chemical transmitters, select the name of the chemical transmitter that acts at both the preganglionic synapse and the effector organ in relation to the cholinergic nervous system.

9-3. Given the name of a part of the body and a group of effects, select the effect(s) produced on that part of the body by the cholinergic nervous system.

9-4. Given the name of one of the types of cholinergic agents and a group of statements, select the statement that best describes that type of agent.

9-5. From a group of statements, select the statement that best describes the difference between reversible cholinesterase inhibitors and irreversible cholinesterase inhibitors.

9-6. Given the trade and/or generic name of a cholinergic agent and a group of indications/ uses cautions and warnings, side effects, or patient warning statements, select the indication/ use, caution and warning, side effect, or patient warning statement that applies to that drug.

9-7. Given the trade or generic name of a cholinergic drug and a group of trade and/or generic names of drugs, select the trade or generic name of the given drug.

SUGGESTION After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 9

CHOLINERGIC AGENTS

9-1. INTRODUCTION

Cholinergic (parasympathomimetic) agents are drugs which when administered will mimic the action of acetylcholine or normal parasympathetic stimulation. As you will remember (lesson 6), the parasympathetic nervous system is responsible for bringing the body back to normal after the fight or flight response. The parasympathetic (cholinergic) nervous system is responsible for maintaining the daily functions performed within the body. This division of the autonomic nervous system serves to conserve energy.

9-2. REVIEW OF THE PHYSIOLOGY OF THE CHOLINERGIC (PARASYMPATHETIC) NERVOUS SYSTEM

The cholinergic (parasympathetic) nervous system is stimulated by the hypothalamus. This nervous system has long preganglionic fibers and short postganglionic fibers (see figure 9-1). The short postganglionic fibers are usually located within the effector organ.

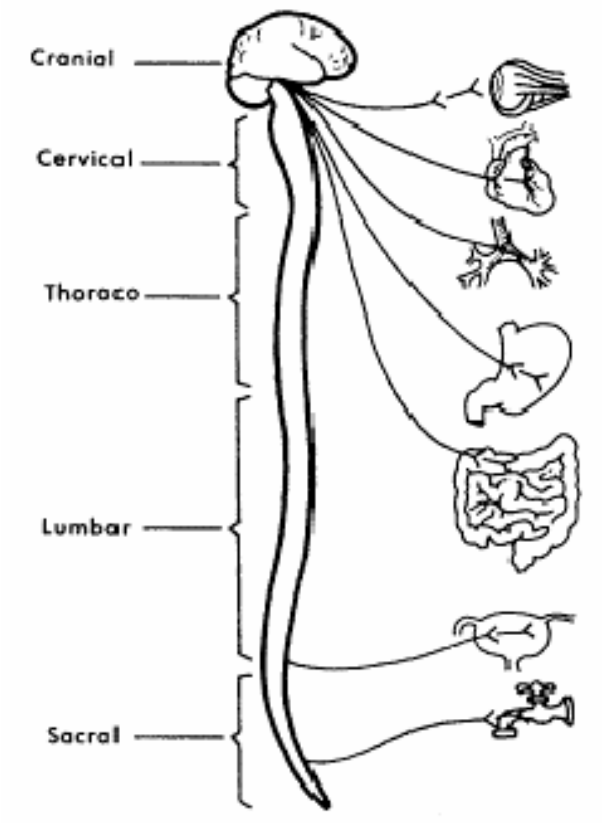

Figure 9-1. The cholinergic (parasympathetic) nervous system.

9-3. CHEMICAL TRANSMISSION IN THE CHOLINERGIC (PARASYMPATHETIC) NERVOUS SYSTEM

The chemical transmitter acts at both the preganglionic synapse and at the effector organ is acetylcholine. Transmission of impulses is terminated by the destruction of acetylcholine by the enzyme acetylcholinesterase.

9-4. EFFECTS PRODUCED BY THE CHOLINERGIC NERVOUS SYSTEM

The general effects of parasympathetic stimulation are conservation and restoration of energy. The specific effects of the cholinergic nervous system are listed below:

a. **Eye (Pupil).** Contraction of the pupil (miosis) is produced by cholinergic stimulation.

b. **Heart**. A decrease in the heart rate and a slight increase in the contraction strength of the heart are cholinergic effects.

c. **Bronchi.** The bronchi are contracted by cholinergic stimulation.

d. **Blood Vessels**. The blood vessels of the skin and mucosa and skeletal muscles are dilated by stimulation by the cholinergic nervous system.

e. **Salivary Glands**. Cholinergic stimulation of the salivary glands leads to profuse, watery secretions.

f. **Stomach**. Cholinergic stimulation of the stomach leads to increased motility and tone and relaxed (usually) sphincters.

g. **Intestines.** Increased intestinal motility and tone and stimulated secretion of intestinal fluids are products of cholinergic stimulation.

h. **Urinary Bladder**. Contraction of the bladder wall and relaxation of the sphincter are products of cholinergic stimulation. The result is that urination is stimulated.

9-5. THERAPEUTIC USE OF CHOLINERGIC AGENTS

The cholinergic (parasympathomimetic) agents mimic the action of acetylcholine. These drugs represent a relatively small class of therapeutic agents with very specific clinical indications. For the most part, cholinergic agents are used in the treatment of glaucoma (see lesson 5) and in the treatment of certain urinary tract disorders (they help produce urination and the emptying of the bladder).

9-6. TYPES OF CHOLINERGIC AGENTS

a. **Direct Acting Agents.** Direct acting drugs have molecules that resemble acetylcholine molecules; thus, they have a direct action on the acetylcholine receptor sites of the postganglionic synapse. These drugs are usually specific in their site of action. An example of a direct acting agent is pilocarpine hydrochloride (Isopto-Carpine®).

(1) Pilocarpine hydrochloride (Isopto-Carpine®). Pilocarpine hydrochloride is a direct acting parasympathomimetic. It is used in the treatment of glaucoma. It causes the contraction of the iris sphincter muscle; this results in miosis (pupil constriction). Pilocarpine can produce the following side effects: muscle tremors, unusual increase in perspiration, unusual watering of the mouth, blurred vision, and eye pain. The patient instilling this medication into the eye should be informed that the drug could cause a change in his near or distant vision. Therefore, he should ensure that his vision is clear before he drives or does any jobs that require him to see well.

(2) Bethanecol chloride (Urecholine®). Bethanecol chloride is a direct acting parasympathomimetic. It is used in the treatment of non-obstructive urinary retention. Bethanecol can produce side effects such as shortness of breath, blurred vision, and dizziness. This drug should not be administered to patients who have bronchial asthma. Patients should be instructed to take the drug on an empty stomach (one or two hours before meals) in order to decrease the probability of having stomach upset.

b. **Indirect Acting Agents**. Indirect acting agents alter or inhibit the activity of acetylcholinesterase. Since the activity of acetylcholinesterase is inhibited or altered, the acetylcholine levels will increase causing cholinergic activity. The indirect acting agents form a complex with acetylcholinesterase. Based upon the type of complex they form, the agents are placed into two groups:

(1) Reversible cholinesterase inhibitors. These agents form a temporary complex with acetylcholinesterase.

(a) Neostigmine (Prostigmin®). Neostigmine is a reversible indirect acting acetylcholinesterase inhibitor. This drug is used in the treatment of myasthenia gravis, a condition characterized by muscle weakness and fatigue. The drug is also used to treat urinary bladder atony. Side effects associated with this agent are diarrhea, abdominal cramps, increased salivation, and increased bronchial secretions.

(b) Physostigmine (Eserine®). Physostigmine is a reversible indirect acting acetylcholinesterase inhibitor. It is used in the treatment of glaucoma. Side effects associated with the use of physostigmine include loss of bladder control, muscle weakness, unusual increase in perspiration, blurred vision or change in distant vision, and headache. The patient using this medication should be warned that it can cause a change in near or distant vision; therefore, the patient should ensure that his vision is clear before he drives or performs any job which requires that he see well.

(2) Irreversible cholinesterase inhibitors. These agents form a stable complex with acetylcholinesterase.

(a) Echothiophate iodide (Phospholine Iodide®). Echothiophate iodide is an irreversible indirect acting acetylcholinesterase inhibitor. It is used in the treatment of glaucoma. The side effects associated with echothiophate include loss of bladder control, muscle weakness, and shortness of breath. You should note that this medication is supplied as a dry powder with diluent. The diluent and the dry powder must be mixed just before you dispense it. The shelf life of the prepared solution can be extended by refrigeration. Since echothiophate may cause changes in the patient's vision, the patient should be warned to insure his vision is clear before he drives or performs any job that requires him to have clear vision.

(b) Demecarium bromide (Humorsol®). Demecarium bromide is an irreversible, indirect acting acetylcholinesterase inhibitor. It is used in the treatment of glaucoma. Side effects that can occur while taking this medication include loss of bladder control, muscle weakness, and shortness of breath. Since this medication may cause changes in the patient's vision, the patient should be warned to ensure his vision is clear before he drives or performs any job which requires him to have clear vision.

Continue with Exercises

EXERCISES, LESSON 9

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which of the following statements best describes the term cholinergic agent?

   a. Drugs which when administered will mimic the action of epinephrine or normal parasympathetic stimulation.

   b. Drugs which when administered will mimic the action of acetylcholine or normal parasympathetic stimulation.

   c. Drugs that produce the same effects as the adrenergic blocking drug.

   d. Drugs that antagonize the effects of the adrenergic nervous system.

2. What is the effect of cholinergic stimulation upon the eye (pupil)?

   a. No effect.

   b. Mydriasis.

   c. Miosis.

3. What is the effect of cholinergic stimulation on the bronchi?

   a. No effect.

   b. Dilation.

   c. Contraction.

4. What is the effect of cholinergic stimulation on the urinary bladder?

    a. No effect.

    b. Urination is stimulated.

    c. Urination is suppressed.

5. Which of the following statements best describes direct acting cholinergic agents?

    a. These agents alter or inhibit the activity of acetylcholinesterase.

    b. These agents form a complex with acetylcholinesterase thus producing cholinergic activity.

    c. These agents reduce the activity of epinephrine in order to enhance the effects of cholinergic stimulation.

    d. These agents have molecules that resemble acetylcholine molecules and produce action on the acetylcholine receptor sites of the postganglionic synapse.

6. Pilocarpine hydrochloride is used in the treatment of:

    a. Nonobstructive urinary retention.

    b. Glaucoma.

    c. Myasthenia gravis.

    d. Obstructive urinary retention.

7. Neostigmine (Prostigmine®) is used in the treatment of:

    a. Nonobstructive urinary retention.

    b. Glaucoma.

    c. Myasthenia gravis.

    d. Obstructive urinary retention.

8. What side effect is associated with the use of physostigmine?

   a. Loss of bladder control.

   b. Unusual decrease in perspiration.

   c. Dryness of the mouth and other mucous membranes.

   d. All the above.

9. Match the trade or generic name in Column A with its appropriate trade or generic name in Column B.

Column A	Column B
_____ Urecholine®	a. Physostigmine
_____ Demecarium bromide	b. Echothiophate iodide
_____ Phospholine iodide®	c. Bethanecol chloride
_____ Eserine®	d. Floropryl®
	e. Humorsol®
	f. Pilocarpine hydrochloride
	g. Isopto-Carpine®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 9

1. b (para 9-1)

2. c (para 9-4a)

3. c (para 9-4c)

4. b (para 9-4h)

5. d (para 9-6a)

6. b (para 9-6a(1))

7. c (para 9-6b(1)(a))

8. a (para 9-6b(1)(b))

9. c Urecholine®. (para 9-6a(2))
   e Demecarium bromide. (para 9-6b(2)(b))
   b Phospholine iodide®. (para 9-6b(2)(a))
   a Eserine®. (para 9-6b(1)(b))

End of Lesson 9

LESSON ASSIGNMENT

LESSON 10 Cholinergic Blocking Agents (Anticholinergic Agents).

TEXT ASSIGNMENT Paragraphs 10-1 through 10-4.

LESSON OBJECTIVES

10-1. From a list of statements, select the statement that best describes how the cholinergic blocking agents produce their effects.

10-2. Given a group of drug categories, select the alternate name sometimes given to cholinergic blocking agents.

10-3. Given the name of a part of the body and a list of pharmacological effects, select the effect of the cholinergic blocking agents on that part.

10-4. Given a list of clinical uses, select the clinical use(s) of the cholinergic blocking agents.

10-5. Given the trade and/or generic name of cholinergic blocking agent and a group of uses, side effects, cautions and warnings, or instructions to the patient, select the use(s), side effect(s), caution(s) and warning(s), and instruction(s) to the patient which are specific to the given drug.

10-6. Given the trade or generic name of a cholinergic blocking agent and a list of trade and/or generic names of drugs, select the trade or generic name for the given drug.

SUGGESTION After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 10

CHOLINERGIC BLOCKING AGENTS (ANTICHOLINERGIC AGENTS)

10-1. INTRODUCTION

In the last lesson, the topic of cholinergic agents was discussed. Now the topic of cholinergic blocking agents (anticholinergic agents) will be discussed. Cholinergic blocking agents block or reduce normal parasympathetic innervation at the postganglionic synapse (see figure 10-1). Drugs in this category are sometimes referred to as parasympatholytics.

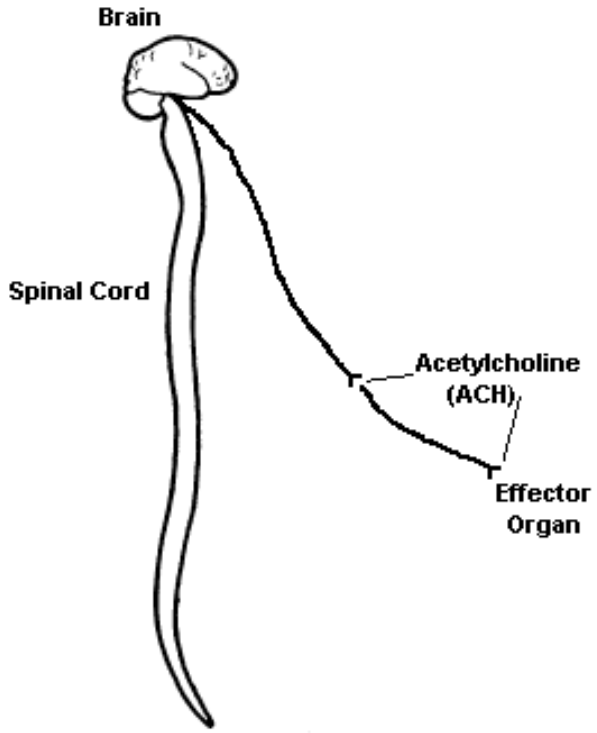

Figure 10-1. The postganglionic synapse--the site of action of the cholinergic blocking agents.

10-2. PHARMACOLOGICAL EFFECTS OF THE CHOLINERGIC BLOCKERS

The cholinergic blockers produce specific effects on certain organs in the body. These effects are:

a. **Stomach/Intestines**. The effect of the cholinergic blockers on the stomach and intestines is decreased activity.

b. **Salivary Glands**. The cholinergic blockers produce a drying effect.

c. **Eye (Pupil).** The cholinergic blockers produce dilation of the pupil (mydriasis).

d. **Urinary Bladder**. The cholinergic blockers produce urinary retention.

e. **Heart**. Increased heart rate is the effect produced on the heart by the cholinergic blockers.

f. **Bronchi.** The cholinergic blockers dilate the bronchi.

10-3. CLINICAL USES OF THE CHOLINERGIC BLOCKERS

The clinical uses of these drugs are based upon their normal pharmacological actions. Their most common clinical uses are listed below:

a. **Antispasmodics**. Antispasmodics are used to slow the motility of the gastrointestinal (GI) tract and reduce gastric secretions. Antispasmodics are commonly prescribed with other types of medications for patients who have ulcers or other GI disorders.

b. **Mydriatics/Cycloplegics.** These agents are used to produce pupil dilation (mydriasis) and to paralyze the muscles of accommodation (cycloplegia). In other words, these drugs prevent the eye from focusing. Medications used for these purposes are commonly used following ocular surgery and for certain types of eye examinations.

c. **Antiparkinsonism Agents**. These drugs are used to treat Parkinsonism, a condition characterized by excessive cholinergic activity in the brain. This condition results in an inability to perform fine motor movements.

d. **Cold Preparations**. Many over-the-counter and legend cold preparations contain cholinergic blocking agents. These cholinergic blockers help to dry secretions (that is, help to “dry” a runny nose).

e. **Antidote for Nerve Gas Poisoning**. Some cholinergic blocking drugs are used as antidotes for persons who have been poisoned by nerve gases (irreversible cholinesterase inhibitors). Certain cholinergic blocking agents are also used as antidotes for certain insecticides (irreversible cholinesterase inhibitors).

f. **Treatment of Bradycardia (Slow Heart Rate).** Atropine sulfate, a cholinergic blocker, is sometimes administered to a patient following cardiac arrest to increase the heart rate. By blocking cholinergic innervation to the heart, sympathetic nerves are allowed to override and increase the rate of the heart.

g. **Preoperative Medication**. Certain cholinergic blockers are administered to patients immediately before their undergoing a surgical procedure. In this case, the cholinergic blockers help to dry secretions in the mucous membranes.

10-4. EXAMPLES OF CHOLINERGIC BLOCKING AGENTS

a. **Atropine**. Atropine is a classic example of the cholinergic blockers. It is found alone and in combination with a wide-variety of other drugs. As an ophthalmic preparation (Isopto-Atropine®), it is used as a cycloplegic and as a mydriatic. Side effects associated with the use of atropine are unsteadiness, hallucinations, unusual dryness of mouth, and increased sensitivity of eyes to light. Patients who have glaucoma should use caution when using this preparation.

b. **Scopolamine.** Scopolamine is another classic example of the cholinergic blockers. Like atropine, scopolamine is found in a variety of medications. It is found in some over-the-counter cold medications. It is present in these products because of the drying effect it produces. In its ophthalmic form it is used as a mydriatic and as a cycloplegic. Side effects that can be caused by this drug include unsteadiness, fever, flushing, or redness of the face, hallucinations, and increased sensitivity of the eyes to light. Patients who have glaucoma should use this preparation with caution.

c. **Homatropine Hydrobomide (Isopto-Homatropine®).** This ophthalmic preparation is used as a mydriatic and as a cycloplegic. The side effects associated with this drug are the same as those associated with atropine and scopolamine (above). Patients who have glaucoma should use this preparation with caution.

d. **Cyclopentolate (Cyclogyl®).** This cholinergic blocker is used as a mydriatic and as a cycloplegic. Cyclopentolate can produce side effects such as unsteadiness, fever, redness of the face, hallucinations, or increased thirst. Patients who have glaucoma should use cyclopentolate with caution.

e. **Belladonna Alkaloids with Phenobarbital (Donnatal®).** This preparation is used as an antispasmodic. Side effects associated with this agent are eye pain (from increased intraocular pressure), constipation, drowsiness, and dryness of the mouth. Patients taking this preparation should be informed of several things. Do not drink alcohol while taking Donnatal® (because of central nervous system depression). Never take this preparation within one hour of taking antacid (the effectiveness of the Donnatal® will be reduced). This drug may cause drowsiness in some patients; therefore, know how the drug will affect him before he drives or performs any job that requires alertness. Belladonna alkaloids sometimes make patients perspire less (this results in increased body temperature); therefore, do not become overheated because of excessive exercise or hot weather.

f. **Propantheline Bromide (Pro-Banthine®).** This agent is used in the treatment of peptic ulcers. Side effects associated with this drug include constipation, difficult urination (because of decreased muscle tone of the urinary bladder), eye pain (from increased intraocular pressure), and dizziness. Patients taking this medication should be informed of several things. Propantheline can produce drowsiness in some patients; therefore, they should ensure they know how the medicine will affect them before they drive or perform activities that require mental alertness. Sometimes patients taking this medication perspire less; therefore, they should ensure they do not become overheated because of excessive exercise or hot weather. Patients that have glaucoma or severe heart disease should use this drug with caution.

g. **Belladonna Tincture**. This preparation is used for its antispasmodic effect on the gastrointestinal tract (effect produced chiefly by its atropine content). Side effects associated with this agent include dryness of the mouth, dizziness, and constipation.

h. **Dicyclomine (Bentyl®).** This preparation is used to relieve smooth muscle spasm of the gastrointestinal tract. Side effects that can be caused by this drug include constipation (caused by decreased peristalsis), difficult urination, and dizziness. Persons taking this drug should be cautioned against taking alcohol or other central nervous system (CNS) depressants.

i. **Trihexyphenidyl (Artane®).** This drug is used in the treatment of parkinsonism. Side effects that can be caused by trihexyphenidyl include constipation, difficult urination, dizziness, dry mouth, and reduced perspiration. Patients taking this preparation should be told several things. Do not take with alcohol or other central nervous system depressants. Some patients perspire less; therefore do not become overheated because of exercise or hot weather.

j. **Benztropine (Cogentin®).** Benztropine is used in the treatment of parkinsonism. The side effects and patient instructions for trihexyphenidyl (Artane®), above, also apply to benztropine.

IMPORTANT NOTE: Sometimes trihexyphenidyl (Artane®) and benztropine (Cogentin®) will be prescribed with certain phenothiazine tranquilizers to help reduce some of the centrally induced side effects produced by the tranquilizers.

NOTE: Drugs listed in paragraphs k and l below are both antiparkinsonism drugs; however, they are NOT cholinergic blockers.

k. **Levodopa (Larodopa®).** This drug is used in the treatment of parkinsonism. Side effects associated with this agent include depression, difficult urination, unusual and uncontrolled movements of the body (that is, face, tongue, and arms), and mood changes. Patients taking this drug should be informed of several things. Take this medication with solid food to decrease the possibility of stomach upset. This drug may cause drowsiness in some patients; therefore, know how the drug will affect him before he drives or performs any job that requires alertness). This drug may cause dizziness or fainting in some patients; therefore, persons taking the drug should get up slowly from a lying or sitting position.

l. **Carbidopa and Levodopa (Sinemet®).** This preparation is used in the treatment of Parkinsonism. Side effects that can be caused by this medication include mental depression) mood changes, unusual and uncontrolled movements of the body (that is, face, tongue, arms), and difficult urination. Patients taking this product should be informed of several things. Patients need to take this medication with solid food to decrease the possibility of stomach upset. This drug may cause drowsiness in some patients; therefore, know how the drug will affect him before he drives or performs any job that requires alertness. This drug may cause dizziness or fainting, persons taking the drug should get up slowly from a lying or sitting position.

Continue with Exercises

EXERCISES, LESSON 10

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete sentence.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. The cholinergic blocking agents produce their effects by:

   a. Forming a stable complex with acetylcholine.

   b. Blocking or reducing normal parasympathetic innervation at the postganglionic synapse.

   c. Increasing the level of epinephrine or norepinephrine at the receptor site.

   d. Preventing the acetylcholinesterase from destroying the acetylcholine at the receptor site.

2. What other name is sometimes given to the cholinergic blocking agents?

   a. Parasympathomimetics.

   b. Para-adrenerolytics.

   c. Parasympatholytics.

   d. Paracholinomimetics.

3. What is the effect of the cholinergic blockers on the urinary bladder?

   a. Urinary concentration.

   b. Urinary stimulation.

   c. Urinary retention.

4. The effect of the cholinergic blockers on the eye (pupil) is:

    a. Miosis (contraction of the pupil).

    b. Mydriasis (dilation of the pupil).

5. What is the clinical use for the cholinergic blocking agents?

    a. Drying agents (in cold preparations).

    b. Antiparkinsonism agents.

    c. Antispasmodics.

    d. All the above.

6. What is the clinical use of Isopto-Atropine®?

    a. Antispasmodic.

    b. Cycloplegic.

    c. Treatment of peptic ulcer.

    d. Treatment of parkinsonism.

7. Persons who take belladonna alkaloids with phenobarbital (Donnatal®) should be cautioned:

    a. Not to take the medication within one hour of taking antacid.

    b. Not to exercise while taking the drug.

    c. Not to take the medication with food or milk.

    d. Not to take other medications while they are taking this product.

8. The product Bentyl® (dicyclomine) is used in the treatment of:

    a. Peptic ulcers.

    b. Glaucoma.

    c. Parkinsonism.

    d. Muscle spasms in the GI tract.

9. What side effect is associated with the use of trihexphenidyl?

    a. Loss of bladder control.

    b. Unusual increase in perspiration.

    c. Dry mouth.

    d. Muscle weakness.

10. Persons taking levodopa (Larodopa®) should be informed that:

    a. They should arise slowly from a sitting or lying position since the drug may cause fainting.

    b. They should take the drug on an empty stomach (one or two hours before meals) to decrease the likelihood of stomach upset.

    c. They should not take the drug with milk or antacid.

11. Match the trade or generic name of Column A with its appropriate trade or generic name in Column B.

Column A		Column B
_____	Trihexyphenidyl	a. Cyclopentolate
_____	Bentyl®	b. Carbidopa and levodopa
_____	Cyclogyl®	c. Cogentin®
_____	Benztropine	d. Dicyclomine
_____	Sinemet®	e. Artane®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 10

1. b (para 10-1)

2. c (para 10-1)

3. c (para 10-2d)

4. b (para 10-2c)

5. d (paras 10-3a, c, and d)

6. b (para 10-4a)

7. a (para 10-4e)

8. d (para 10-4h)

9. c (para 10-4i)

10. a (para 10-4k)

11. e Trihexyphenidyl (para 10-4i)
    d Bentyl® (para 10-4h)
    a Cyclogyl® (para 10-4d)
    c Benztropine. (para 10-4j)
    b Sinemet®. (para 10-4l)

End of Lesson 10

ANNEX

DRUG PRONUNCIATION GUIDE

This Drug Pronunciation Guide was developed to help you to learn how the trade and generic names of commonly prescribed medications are frequently pronounced. Not all the drugs in the guide are discussed in this subcourse. Remember, it is not enough to be able to know the uses, indications, cautions and warnings, and contraindications for a drug--you must also know how to pronounce that drug's name.

Trade Name	***Generic Name***
A	
Actifed (Ak'-ti-fed)	Triprolidine (Tri-pro'-li-deen) and Pseudoephedrine (Soo-do-e-fed'-rin)
Adapin (Ad'-a-pin)	Doxepin (Dok'-se-pin)
Sinequan (Sin'-a-kwan)	" "
Afrin (Af'-rin)	Oxymetazoline (Ok-see-met-az'-o-leen)
Aldactazide (Al-dak'-ta-zide)	Spironolactone (Spi-ro-no-lak'-tone) and Hydrochlorothiazide (Hy-dro-klor-thi'-a-zide)
Aldactone (Al-dak'-tone)	Spironolactone (Spi-ro-no-lak'-tone)
Aldomet (Al'-do-met)	Methyldopa (Meth-il-do'-pah)
Alupent (Al'-u-pent)	Metaproterenol (Met-a-pro-ter'-eh-nol)
Amoxil (Am-ok'-sil)	Amoxicillin (Ah-moks'-i-sil-in)
Amphojel (Am'-fo-jel)	Aluminum (Al-loo'-mi-num) Hydroxide (Hy-drok'-side)
Ampicillin (Amp'-I-sil-in)	Same
Antepar (Ab'-te-par)	Piperazine (Pi-per'-ah-zeen)
Anturane (An'-tu-rain)	Sulfinpyrazone (Sul-fin-pie'-ra-zone)
Anusol (An'-u-sol)	Pramoxine (Pram-ok'-seen)
Apresoline (A-press'-o-leen)	Hydralazine (Hy-dral'-ah-zeen)
Aralen (Ar'-a-len)	Chloroquine (Klor'-o-kwin)
Aristocort (A-ris'-to-cort)	Triamcinolone (Tri-am-sin'-o-lone)
Artane (Ar'-tane)	Trihexyphenidyl(Tri-hek-see-fen'-i-dil)
A.S.A.	Aspirin (As'-per-in)
Atromid S (A'-tro-mid)	Clofibrate (Klo-fi'-brate)
Avlosulfon (Av-lo-sul'-fon)	Dapsone (Dap'-sone)
Azolid (Az'-o-lid)	Phenylbutazone (Fen-il-bute'-a-zone)
B	
Bactrim (Bak'-trim)	Sulfamethoxazole (Sul-fah-meth-oks'-ah-zole) and Trimethoprim (Tri-meth'-o-prim)
Bellergal (Bel'-er-gal)	Ergotamine (Er-got'-a-meen), Phenobarbital (Feen-o-bar'-bi-tal) and Belladonna (Bel-la-don'-na) Alkaloids

Trade Name	*Generic Name*
Benadryl (Ben'-a-dril)	Diphenhydramine (Di-fen-hy'-dra-meen)
Bendectin (Ben-dek'-tin)	Doxylamine (Dok-sil'-a-meen)
Benemid (Ben'-eh-mid)	Probenecid (Pro-ben'-eh-sid)
Bonine (Bo'-neen)	Meclizine (Mek'-li-zeen)
C	
Cafergot (Kaf'-er-got)	Ergotamine (Er-got'-a-meen) and Caffeine (Kaf'-feen)
Calamine (Kal'-a-mine)	Same
Catapres (Kat'-a-press)	Clonidine (Klo'-ni-deen)
CeeNu (See'-new)	Lomustine (Lo-mus'-teen)
Chlor-Trimeton (Klo-tri '-meh-ton)	Chlorpheniramine (Klor-fen-it'-a-meen)
Clomid (Klo'-mid)	Clomiphene (Klo'-mi-feen)
Clonopin (Klo-o-pin)	Clonazepam (Klo-na'-ze-pam)
Codeine (Ko'-deen)	Same
Cogentin (Ko-jen'-tin)	Benztropine (Benz'-tro-peen)
Colace (Ko'-lace)	Dioctyl(Di-ok'-til) Sodium (So'-dee-um) Sulfosuccinate (Sul-fo-suk'-si-nate)
Colchicine (Kol'-chi-seen)	Same
Compazine (Kom'-pa-zeen)	Prochiorperazine (Pro-klor-per'-a-zeen)
Cordran (Kor'-dran)	Flurandrenolide (Floor-an-dren'-o-lide)
Coumadin (Koo'-mah-din)	Warfarin (War'-fah-rin)
CP	Cloroquine (Klor'-o-kwin) and Primaquine (Prim'-a-kwin)
Cyclogyl (Si'-klo-jel)	Cyclopentolate (Si-klo-pen'-to-late)
Cytomel (Si'-to-mel)	Liothyronine (Li-o-thy-ro-neen)
Cytoxan (Si-tok'-san)	Cyclophosphamide (Si-klo-fos'-fa-mide)
D	
Dalmane (Dal '-mane)	Flurazepam (Floor-az'-e-pam)
Darvocet (Dar'-vo-set)	Propoxyphene (Pro-pok'-se-feen) and Acetaminopen (As-et-am'-ino-fen)
Darvon (Dar'-von)	Propoxyphene (Pro-pok-se-feen)
Decadron (Dek'-a-dron)	Dexamethasone (Dek-sa-meth'-ah-sone)
Deltasone (Del '-ta-sone)	Prednisone (Pred'-ni-sone)
Demerol (Dem'-er-ol)	Meperidine (Meh-pair'-i-deen)
Dexedrine (Deks '-eh-dreen)	Dextroamphetamine (Deks-tro-am-fet'-a-meen)
Diabinese (Di-ab'-i-nees)	Chlorpropamide (Klor-prop'-a-mide)
Diethylstilbestrol (Di-eth-il-stil-bes'-trol)	Same
Dilantin (Di-lan'-tin)	Phenytoin (Fen'-i-toin)
Dilaudid (Di-law'-did)	Hydromorphone (Hy-dro-more' -fon)
Dimetane (Di'-meh-tane)	Brompheniramine (Brom-fen-ir'-a-meen)

Trade Name	*Generic Name*
Dimetapp (Di‘-meh-tap)	Brompheniramine (Brom-fen-ir’-a-meen) Phenylephrine (Fen-il-ef’-rin) and Phenylpropanolamine (Fen-il-pro-pan-ol‘-a-meen)
Disophrol (Dice’-o-frol)	Dexbrompheniramine (Deks-brom-fen-ir‘-a-meen) and Pseudoephedrine (Soo-do-e-fed‘-rin)
Dolophine (Dol‘-o-feen)	Methadone (Meth’-a-done)
Domeboro (Dome-bor’-o)	Aluminum (Ah-loo’-mi-num) Acetate (As‘-e-tate)
Donnatal (Don’-na-tal)	Belladonna (Bel-la-don’-na) Alkaloids (Al’-ka-loids) and Phenobarbital (Feen-o-barb’-i-tal)
Doxidan (Dok’-si-dan)	Danthron (Dan’-thron) and Dicctyl (Di-ok’-til) Calcium (Kal‘-see-um) Sulfosuccinate (Sul-fo-suk’-si-nate)
Drixoral (Driks’-or-al)	Dexbrompheniramine (Deks-brom-fen-ir’-a-meen) and Pseudoephedrine (Soo-do-e-fed‘-rin)
Dulcolax (Dul’-ko-laks)	Bisacodyl (Bis-a’-ko-dil)
Dyazine (Di’-a-zide)	Triamterene (Tri-am’-ter-een) and Hydrochlorothiazide (Hy-dro-klor-o-thi‘-a-zide)
Dymelor (Die’-meh-lor)	Acetohexamide (As-e-to-heks’-a-mide)
Dyrenium (Die-ren’-i-um)	Triamterene (Tri-am’-ter-een)
E	
Efudex (Ef'-u-deks)	Fluorouracil (Floo-ro-ur’-ah-sil)
Elavil (El’-ah-vil)	Amitriptyline (Am-i-trip’-til-een)
Elixir Terpin (Ter’-pin) Hydrate	Same
Empirin (Em’-per-in)	Codeine (Ko’-deen) and Aspirin (As’-per-in)
E-Mycin (E-mie’-sin)	Erythromycin (E-rith-ro-mie’-sin)
Equanil (Ek’-wa-nil)	Meprobamate (Me-pro-bam’-ate)
Ergomar (Er’-go-mar)	Ergotamine (Er-got’-a-meen)
Ergotrate (Er’-go-trate)	Ergonovine (Er-go-no’-veen)
Erythrocin (Er-eeth’-ro-sin)	Erythromycin (Er-eeth-ro-my’-sin) Stearate (Stare’-rate)
Esidrix (Es’-i-driks)	Hyrochlorothiazide (Hy-dro-klor-o-thi‘-a-zide)
F	
Feosol (Fe’-o-sol)	Ferrous (Fer’-rus) Sulfate (Sul’-fate)
Fergon (Fer’-gon)	Ferrous (Fer’-rus) Gluconate (Glu'-con-ate)

Trade Name	*Generic Name*
Fiorinal (Fee-or'-i-nal)	Butalbi tal (Bu-tal'-bi-tal), Apririn, Phenacetin (Fen-ass'-eh-tin), and Caffeine (Kaf'-feen)
Flagyl (Fla'-jil)	Metronidazole (Me-tro-ni'-dah-zole)
Flexeril (Flek'-sa-ril)	Cyclobenzaprine (Si-klo-benz'-a-preen)
Fulvicin (Ful'-vi-sin)	Griseofulvin (Griz-e-o-ful'-vin)
G	
Guantanol (Gan'-ta-nol)	Suiphamethoxazole (Sul-fah-meth-oks'-ah-zole)
Gantrisin (Gan'-tri-sin)	Sulfisoxazole (Sul-fi-sok'-sah-zole)
Gelusil (Jel'-u-sil)	Aluminum (Ah-loo'-mi-num) Hydroxide (Hy-drok'-side) and Magnesium (Mag-nee'-zee-um) Hydroxide
Grifulvin (Gri-ful'-vin)	Griseofulvin (Griz-e-o-ful'-vin)
Gynergen (Jin'-er-jen)	Ergotamine (Er-got'-a-meen)
H	
Haldol (Hal'-dol)	Haloperidol (Hal-o-pair'-i-dol)
Halotestin (Hal-o-tes'-tin)	Fluoxymesterone (Floo-ok-see-mes-teh-rone)
Hexadrol (Hek'-sa-drol)	Dexamethasone (Dek-sa-meth'-a-sone)
Hydrodiuril (Hy-dro-di'-ur-il)	Hydroclorothiazide (Hy-dro-kior-thi'-a-zide)
Hygroton (Hy-grow'-ton)	Chiorthalidone (Kior-thal'-i-done)
I	
Ilosone (I'-low-sone)	Erythromycin (Er-ith-ro-mi'-sin) Estolate (Es'-to-late)
Inderal (In'-der-al)	Propranolol (Pro-pran'-o-lol)
Indocin (In'-do-sin)	Indomethacin (In-do-meth'-a-sin)
INH	Isoniazid (I-so-ni'-a-zid)
Insulin (In'-sul-in)	Same
Intal	Cromolyn (Kro'-mo-lin)
Ismelin (Is'-meh-lin)	Guanethidine (Gwan-eth'-i-dine)
Isopto-Atropine (I-sop-to-at'-ro-peen)	Atropine (At'-ro-peen)
Isopto-Carpine (I-sop-to-car'-peen)	Pilocarpine (Pile-o-car'-peen)
Isordil (I'-sor-dil)	Isosorbide (I-so-sor'-bide)
J-K	
Keflex (Kef'-lex)	Cephalexin (Sef-ah-lek'-sin)
L	
Lanoxin (Lan-ok'-sin)	Digoxin (Di-jok'-sin)
Larodopa (Lar-o-do'-pa)	Levodopa (Le-o-do'-pa)
Larotid (Lar'-o-tid)	Amoxicillin (Ah-moks'-i-sil-in)
Lasix (La'-siks)	Furosemide (Fu-ro'-se-mide)
Leukeran (Lu'-ker-an)	Chlorambucil (Klor-ram'-bu-sil)

Trade Name	*Generic Name*
Librium (Lib'-ree-um)	Chlordiazepoxide (Klor-die-az-eh-pok'-side)
Lidex (Lie'-deks)	Fluocinoide (Floo-o-sin'-o-nide)
Lomotil (Lo'-mo-til)	Diphenoxylate (Die-fen-ok'-si-late)
Lopressor (Lo'-pres-sor)	Metoprolol (Met-o-pro'-lol)
Lotrimin (Lo'-tri-min)	Chlotrimazole (Klo-trim'-ah-zole)
M	
Maalox (May'-loks)	Aluminum (Ah-loo'-mi-num) and Magnesium (Mag-nee'-zee-um) Hydroxides
Macrodanton (Ma-kro-dan'-tin)	Nitrofurantoin (Ni-tro-fur-an'-toin)
Mandelamine (Man-del'-a-meen)	Methenamine (Meth-en'-a-meen) Mandelate (Man'-deh-late)
Medihaler-Iso (Med-i-hail-er-I'-so)	Isoproterenol (I-so-pro-ter'-en-ol)
Mellaril (Mel'-la-ril)	Thioridazine (Thi-o-rid'-a-zeen)
Metamucil (Met-a-mu'-sil)	Psyllium (Sil'-e-um)
Metaprel (Meh'-ta-prel)	Metaproterenol (Meh'-ta-pro-ter'-eh-nol)
Methotrexate (Meth-o-treks'-ate)	Amethopterin (Ah-meth-op'-ter-in)
Milk of Magnesia	Same
Minipress (Min'-i-press)	Prazosin (Pra'-zo-sin)
Minocin (Min'-o-sin)	Minocycline (Mi-no-si'-kleen)
Monistat (Mon'-i-stat)	Miconazole (Mi-kon'-ah-zole)
Motrin (Mo'-trin)	Ibuprofen (I-bu'-pro-fen)
Myambutol (My-am'-bu-tol)	Ethambutol (Eth-am'-bu-tol)
Mycostatin (My-co-stat'-in)	Nystatin (Ny-stat'-in)
Mylanta (My-lan'-ta)	Aluminum (Ah-loo'-mi-num) and Magnesium (Mag-nee'-zee-um) Hydroxides and Simethicone (Si-meth'-i-kone)
Myleran (My-ler-an)	Busulfan (Bu-sul'-fan)
Mylicon (My'-li-kon)	Simethicone (Si-meth'-i-kone)
Mysoline (My'-so-leen)	Primidone (Pri'-mi-done)
N	
Nalfon (Nal'-fon)	Fenoprofen (Fen-o-pro'-fen)
Naprosyn (Na'-pro-sin)	Naproxen (Na-prok'-sen)
Nembutal (Nem'-bu-tal)	Pentobarbital (Pen-to-barb'-i-tal)
Neosynephrine (Nee-o-sin-eh'-frin)	Phenylephrine (Fen-il-eh'-frin)
Nitrobid (Ni'-tro-bid)	Nitroglycerin (Ni-tro-gli'-ser-in)
Nitrol (Ni'-trol)	"
Nitrostat (Ni-tro-stat)	"
Noctec (Nok'-tek)	Chloral Hydrate (Klor'-al- Hy'-drate)
Norfiex (Nor'-fleks)	Orphenadrine Citrate (Or-fen'-a-dreen)
Norpace (Nor'-pace)	Disopyramide (Di-so-peer'-a-mide)

Trade Name	*Generic Name*
Novahistine (No-va-his'-teen) Expectorant	Guaifenesin (Gwi-fen'-eh-sin), Phenylpropanolamine (Fen-il-pro-pan-ol'-a-meen), and Codeine (Ko'-deen)
NTG	Nitroclycerin (Ni-tro-gli'-ser-in)
Nupercainal (New-per-kain'-al)	Dibucaine (Die'-bu-kain)
O	
Oretic (O-ret'-ik)	Hydrochiorothiazide (Hy-dro-kior-thi'-a-zide)
Orinase (Or'-in-ase)	Tolbutamide (Tol-bu'-tah-mide)
Ornade (Or'-nade)	Chlorpheniramine (Klor-fen-ir'-a-meen), Triprolidine (Tri-pro-li-deen) and Pseudoephedrine (Su-do-eh-fed'-rin)
P	
Parafon Forte (Pair'-a-fon For'-tay)	Chlorzoxazone (Klor-zok'-sa-zone)
Percodan (Per'-ko-dan)	Oxycodone (Ok-si-ko'-done)
Periactin (Per-ee-ak'-tin)	Cyproheptadine (Si-pro-hep'-tah-deen)
Persantine (Per-san'-teen)	Dipyridamole (Di-pi-rid'-ah-mole)
Phenobarbital (Feen-o-barb'-it-al)	Same
Phenylpropanolamine (Fen-il-pro-pan-ol'-a-meen)	Same
Pitocin (Pi-tow'-sin)	Oxytocin (Ok-see-tow'-sin)
Pontocaine (Pon'-to-kain)	Tetracaine (Teh'-tra-kain)
Povan (Po'-van)	Pyrvinium (Pire-vin'-ee-um)
Premarin (Prem'-ar-in)	Conjugated (Kon'-joo-gay-ted) Estrogens (Es-tro-jens)
Presamine (Press'-a-meen)	Imipramine (Im-ip'-rah-meen)
Primaquine (Pri'-mah-kwin)	Same
Probanthine (Pro-ban'-theen)	Propantheline (Pro-pan'-the-leen)
Pronestyl (Pro-nes'-til)	Procainamide (Pro-kain'-a-mide)
Prophylthiouracil (Pro-pil-thi-o-u'-rah-sil)	Same
Prostaphlin (Pro-staff'-lin)	Oxacillin (Oks'-ah-sil-in)
Provera (Pro-ver'-ah)	Medroxyprogesterone (Med-rok-see-pro-jes'-ter-one)
Pyridium (Pie-rid'-ee-um)	Phenazopyridine (Fen-ahs-o-per'-i-deen)
Q	
Quinidine (Kwin'-i-deen)	Same
Quinine (Kwie'-nine)	Same
R	
Reserpine (Ree-ser'-peen)	Same
Retin A (Reh'-tin A)	Tretinoin (Tret'-i-noin)
Rifadin (Rie-fad'-in)	Rifampin (Rie-fam'-pin)
Riopan (Rie'-o-pan)	Magaidrate (Mag'-al-drate)

Trade Name	*Generic Name*
Rimactane (Rim-act'-ane)	Rifampin (Rie-fam'-pin)
Ritalin (Rit'-a-lin)	Methylphenidate (Meth-il-fen'-i-date)
Robaxin (Ro-bak'-sin)	Methocarbamol (Meth-o-kar'-ba-mol)
Robitussin (Row-i-tus'-sin)	Guaifenesin (Gwie-fen'-eh-sin)
Robitussin DM	Guiafenesin and Dextromethorphan (Dek-tro-meh-or'-fan)
S	
Sansert (San'-sert)	Methysergide (Meth-ee-ser'-jide)
Seconal (Sek'-o-nal)	Secobarbital (Sek-o-bar'-bi-tal)
Selsun (Sel'-sun)	Selenium (Se-leh'-nee-um)
Septra (Sep'-tra)	Sulfamethoxazole (Sul-fah-meth-oks'-a-zole) and Trimethroprim (Tri-meth'-o-prim)
Serax (See'-raks)	Oxazepam (Oks-az'-eh-pam)
Silvadene (Sil'-va-deen)	Silver Sulfadiazine (Sul-fa-die'-a-zeen)
Sinemet (Si'-ne-met)	Levodopa (Le-vo-do'-pa)
Sinequan (Sin'-a-kwan)	Doxepin (Dok'-seh-pin)
Sorbitrate (Sor'-bi-trate)	Isosorbide (I-so-sor'-bide)
Stelazine (Stel'-a-zeen)	Trifluoperazine(Tri-floo-o-per'-a-zeen)
Sudafed (Soo'-da-fed)	Pseudophedrine (Soo-do-eh-feh'-drin)
Sulamyd (Sul'-a-mid)	Sulfacetamide (Sul-fah-set'-a-mide)
Sulfamylon (Sul-fa-mie'-lon)	Mafenide (Maf'-eh-nide)
Sultrin (Sul'-trin)	Sulfathiazole (Sul-fah-thi'-ah-zole) Sulfacetamide (Sul-fah-set'-ah-mide) and Sulfabenzamide (Sul-fah-benz'-ah-mide)
Surfak (Sur'-fak)	Dioctyl (Di-ok'-til) Calcium (Kal'-see-um) Sulfosuccinate (Sul-fo-suk'-si-nate)
Synalar (Sine'-a-lar)	Fluocinolone (Floo-o-sin'-o-lone)
Synthroid (Sin'-throid)	Levothyroxine (Lee-vo-thi-rok'-sin)
T	
Tace (Tace)	Chlorotrianisene (Klor-o-tri-an'-I-seen)
Tagamet (Tag'-a-met)	Cimetidine (Si-met'-i-deen)
Talwin (Tal'-win)	Pentazocine (Pen-taz'-o-seen)
Tandearil (Tan'-da-ril)	Oxyphenbutazone (Ok-see-fen-bute'-a-zone)
Tegretol (Teg'-reh-tol)	Carbamazepine (Kar-ba-maz'-eh-peen)
Tessalon (Tess'-a-lon)	Benzonatate (Benz-on'-a-tate)
Tetracycline (Tet-ra-si'-kleen)	
Thorazine (Thor'-a-zeen)	Chlorpromazine (Klor-pro'-ma-zeen)
Thyroid (Thy'-roid)	Same
Tigan (Tie'-gan)	Trimethobenzamide (Tri-meth-o-benz'-a-mide)
Timoptic (Tim-op'-tic)	Timilol (Tim'-o-lol)

Trade Name	*Generic Name*
Tinactin (Tin-act'-in)	Tolnaftate (Tol-naf'-tate)
Titralac (Ti'-tra-lak)	Calcium (Kal-see-um) Carbonate (Kar'-bon-ate) and Glycine (Gly'-seen)
Tofranil (Toe'-fra-nil)	Imipramine (I-mip'-rah-meen)
Tolectin (Tow-lek'-tin)	Tolmetin (Tol-met'-in)
Triavil (Tri'-a-vil)	Perphenazine (Per-fen'-a-zeen) and Amitriptlyline (Am-i-trip'-ti-leen)
Trilafon (Try'-la-fon)	Perphenazine (Per-fen-a-zeen)
Tylenol (Tie'-leh-nol)	Acetaminophen (As-et-am'-ino-fen)
Tylenol #3	Acetaminophen and Codeine (Ko'-deen)
U	
Unipen (U'-ni-pen)	Nafcillin (Naf-sil-lin)
Urecholine (Ur-eh-ko'-leen)	Bethanecol (Beth-an'-eh-kol)
V	
Valisone (Val'-i-sone)	Betamethasone (Beh-tah-meth'-a-sone)
Valium (Val'-ee-um)	Diazepam (Die-aze-eh-pam)
Vermox (Ver'-moks)	Mebendazole (Meh-ben'-dah-zole)
Vibramycin (Vie-bra-my'-sin)	Doxycycline (Doks-see-si'-kleen)
W-X	
Xylocaine (Zie'-low-kain)	Lidocaine (Lie-do-kain)
Y-Z	
Zarontin (Zar-on'-tin)	Ethosuximide (Eh-tho-suks'-a-mide)
Zyloprim (Zie'-low-prim)	Allopurinol (Al-lo-pure'-in-ol)

End of Annex